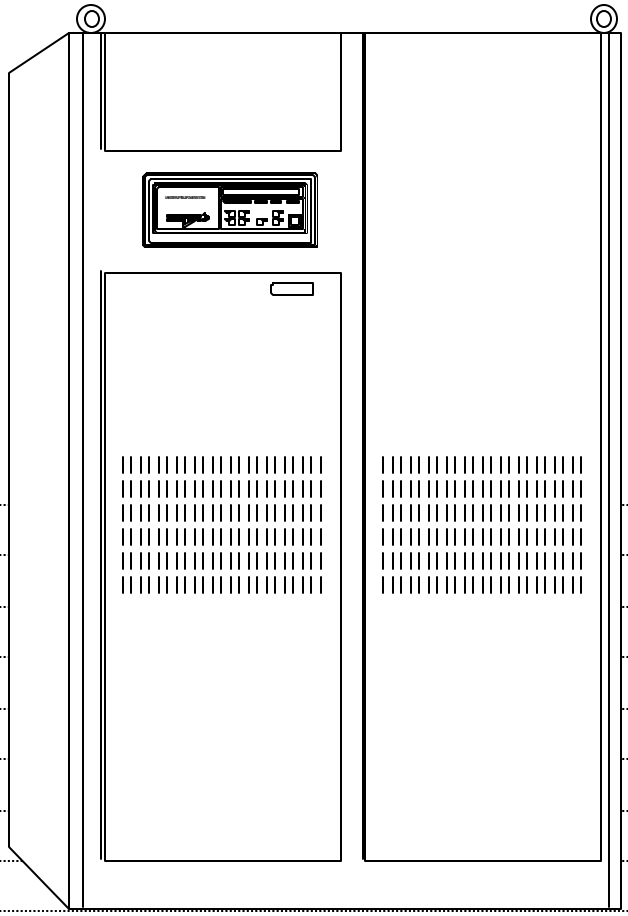
Series 7400 *Single Phase UPS system*

Single module and '1 + N' (expandable)



User Manual

EMERSON Network Power

EMERSON Network Power (India) Pvt. Ltd.

Dear Customer,

Please accept our thanks for giving us the privilege to serve you by choosing a Liebert make 'UPS'.

If this is your first Liebert UPS, we hope it is the beginning of a long relationship which delivers value to your organisation. If you already own and use a Liebert, we are doubly honoured by your decision of continuing this relationship.

*It is our constant endeavour to partner you for the growth and success of your business. This philosophy is reflected in our Mission statement "**To deliver value through Air & Power Quality solutions to achieve customer delight".** Please do give us feedback to help us realize our Mission.*

Emerson Network Power (India) Private Limited

IMPORTANT

This manual contains information concerning the installation, operation and maintenance of the Series 7400 1Phase Uninterruptible Power System (UPS) for the single module and one plus one Systems.

All relevant parts of the manual should be read prior to commencing installation.

The UPS must be commissioned by an engineer approved by the manufacturer (or his agent) before being put into service. Failure to observe this condition will invalidate any implied warranty.

The Series 7400 1Phase UPS has been designed for Commercial / Industrial use only.

The Series 7400 1Phase UPS is not designed for direct use in any life support application.

If you encounter any problem with the procedures contained in this manual you should seek immediate assistance from Emerson Network Power (India) Pvt. Ltd. Sales Office from whom the equipment was purchased. Alternatively contact the Emerson Network Power (India) Pvt. Ltd. Customer Service & Support department at the address shown below:

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Emerson Network Power (India) Pvt. Ltd. pursues a policy of continual product development and reserves the right to change the equipment without notice.

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Safety Procedure

WARNING

This is a class A UPS product. In a domestic environment, this product may cause radio interface in which case the user may be required to take additional measures.

WARNING

HIGH EARTH LEAKAGE CURRENT: EARTH CONNECTIONS IS ESSENTIAL BEFORE CONNECTING THE INPUT SUPPLY.

This equipment must be earthed in accordance with local electrical codes.

WARNING

THIS UPS DOES NOT INCORPORATE AUTOMATIC BACKFEED PROTECTION. A WARNING LABEL MUST BE FITTED TO ALL EXTERNAL PRIMARY POWER ISOLATIONS STATING.

INSULATE THE UNINTERRUPTIBLE POWER SYSTEM BEFORE WORKING ON THIS CIRCUIT.

GENERAL

As with other types of high power equipment, dangerous voltages are present within the UPS and battery enclosure. The risk of contact with these is minimised as the live component parts are housed behind a hinged, lockable door. Further internal safety screens make the equipment protected to IP20 standards.

No risk exists to any personnel when operating the equipment in the normal manner, following the recommended operating procedures.

All equipment maintenance and servicing procedures involve internal access and should be carried out only by trained personnel.

BATTERIES

Battery manufacturers supply details of the necessary precautions to be observed when working on, or in the vicinity of a large bank of battery cells. These precautions should be followed implicitly at all times.

Particular attention should be paid to the recommendations concerning local environmental conditions and the provision of protective clothing, first-aid and fire fighting facilities

TEST EQUIPMENT

When the battery is under charge, it is earth-referenced about its mid-point –e.g. if the battery s being charged at 460V the battery extremities will be at +230V and –230V with respect to neutral (earth). When using mains-powered test equipment such as oscilloscopes in the UPS voltage area, always use a differential mode of operation to disconnect the oscilloscope frame earth.

PERSONNEL

When working inside the UPS (trained personnel only) it is recommended that protection be worn to prevent eye damage, should an electric ware be struck by mishandling or severe electrical fault.

Some of the power components are very heavy. If their removal is necessary, ensure that sufficient manpower is available; otherwise use adequate mechanical handling equipment.

When working in the general area of the UPS where high voltages are present, a second person should be standing-by to assist and summon help in case of accident.

INDEX

Chapter 1
General Description

1.1 Introduction

The Uninterruptible Power Supply system is connected between a critical load, such as digital drives & automation, distributed digital Process Control System, telecom equipment, programmable logic controller, mission critical applications, computer, and its three phase mains power supply. Being designed to furnish a well regulated 1 PH output power supply under all rated load and input supply conditions the system offers the users the following advantages: -

Increased power quality :
The UPS has its own internal voltage and frequency regulator circuits which ensure that its output is maintained within close tolerances independent of voltage and frequency variations on the mains power lines.

Increased noise rejection :
By rectifying the input AC power to DC power, and then converting it back to AC, any electrical noise present on the input mains supply line is effectively isolated from the UPS output, therefore the critical load sees only clean power.

Power blackout protection:
If the mains power fails, the UPS continues to power the critical load from its battery source, leaving the load immune from power disturbances.

1.2 Design Concepts

1.2.1 Redundant vs Non-Redundant configuration

The *one-plus-one* system comprises two standard 7400 series UPS modules which are modified to allow their outputs to be connected in parallel. These can then be used in a "redundant" or "non-redundant" configuration as explained below.

In a non-redundant module configuration, the system is sized such that both UPS modules are required to feed the potential load, and if one of the two modules develops a fault, or is for some reason shut down, the other module automatically shuts down also.

***Note**: In such an event the load is transferred to an unprocessed bypass supply - as described later.*

In a redundant module configuration the system is sized such that the potential load can be provided by just one of the two modules. Under normal circumstances both modules are operational and share the load current equally; but if one module develops a fault, or is shut down, the second module is able to take over the full load demand and continue to provide it with processed, backed-up power. The advantages of a redundant system over a non-redundant system in terms of overall system reliability are self-evident.

Changing a *one-plus-one* system's configuration between redundant and non-redundant is quite straightforward, being carried out by configuration links on the circuit board, which governs the modules' parallel control operation.

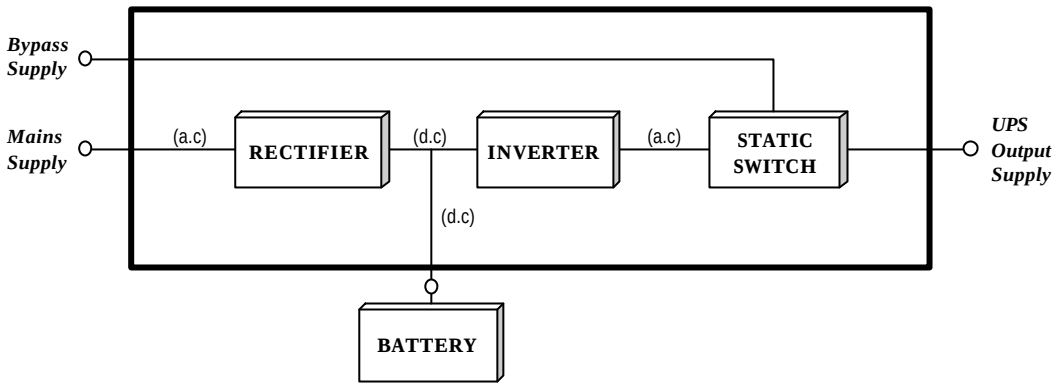


Figure 1: Series 7400 UPS Single Module Block Diagram

1.2.2 7400 Module Design

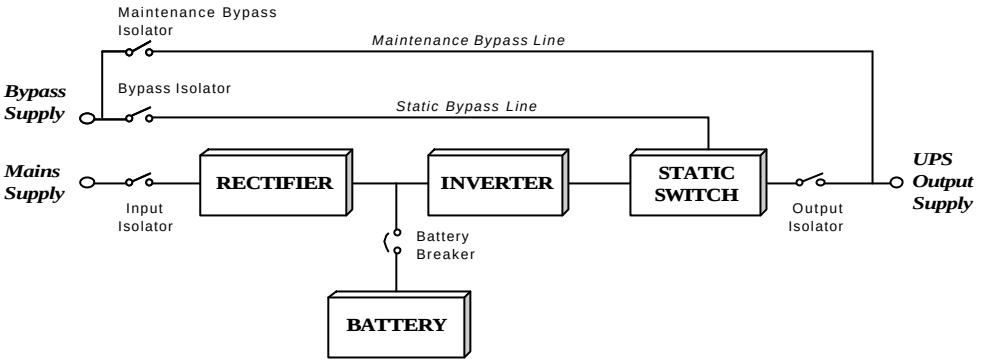
As previously mentioned, each of the two modules forming the *one-plus-one* system is basically a standard single module 7400 series UPS. This section describes an individual module's operating principles - the effects of the additional parallel control facilities on the standard module are described later.

The UPS basically operates as an AC-DC-AC converter (see figure 1). The first conversion stage (from AC to DC) uses a 3 Phase, fully-controlled SCR bridge rectifier to convert the incoming mains supply into a regulated 432V DC busbar.

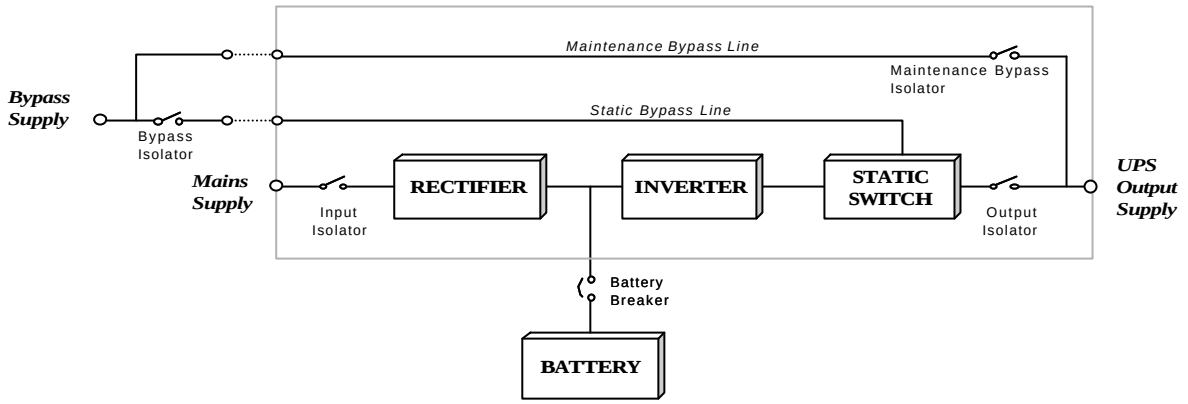
The DC busbar produced by the rectifier provides both battery charging power and power to the inverter section -which is of a transistorised / IGBT based pulse width modulation (PWM) design and provides the second conversion phase; i.e. reconverting the DC busbar voltage back into an AC voltage waveform.

During normal operation both the rectifier and inverter sections are active and provides regulated load power whilst simultaneously float charging the battery. In the event of a mains power failure, the rectifier becomes inoperative and the inverter is powered solely from the battery. Critical load power is maintained under these conditions until the battery is fully discharged, whereupon the UPS shuts down. The end of battery discharge is assumed when the battery voltage falls to 320Vdc. In case of 80 to 125 kVA, 1 PH models the end of discharge is taken as 330Vdc.

The period for which the load can be maintained following a mains power failure is known as the system's *'Autonomy Time'* and is dependent upon both the battery A/Hr capacity and the applied percentage load. It is usual in larger installations to provide an alternative UPS input power source from a stand-by generator when the mains supply fails. Once such a generator has been brought on-line, and the UPS input power has been re-established, the batteries immediately begin to recharge. Modern generators can be started and brought on-line very quickly and where such a facility is incorporated into the UPS installation it results in short battery discharge periods and correspondingly rapid recharge times.



A. BLOCK SCHEMATIC FOR 230V OUTPUT 1PH. UPS SYSTEM



B. BLOCK SCHEMATIC FOR 110V OUTPUT 1PH. UPS SYSTEM

Figure 2: Series 7400 UPS Isolator configurations

1.2.3 Bypass Supplies

The circuit block annotated 'Static Switch' in figure 2 contains an electronically controlled switching circuit, which enables the critical load to be connected either to the Inverter output or to a Bypass power source via the 'static bypass line'. Normally, the load is connected to the inverter; but in the event of a UPS overload, or inverter failure, it is automatically transferred to the static bypass line due to static switch action. Note that the Bypass supply should be in normal condition and enabled.

To provide a clean (no-break) load transfer between the inverter output and static bypass line, the inverter output and bypass supply must be fully synchronised during normal operating conditions. This is achieved through the inverter control electronics which make the inverter frequency track that of the static bypass supply - provided that the bypass remains within an acceptable frequency window. The synchronising window is pre-selected to 2% of nominal frequency, giving an acceptable frequency window of ±1Hz.

A warning message [INVERTER UNSYNCHRONIZED] is displayed on the operator control panel when the inverter and bypass supplies are not synchronized.

A second, manually controlled, 'Maintenance bypass' supply is also incorporated into the UPS design. Its purpose it to enable the critical load to be powered from the mains (bypass) supply while the UPS is shut down for maintenance or troubleshooting.

***Note**:- The load is unprotected against mains power supply aberrations or failure when it is connected to either the static bypass or maintenance bypass supply.*

1.2.4 UPS Power Switch Configuration

Figure 2 illustrates what is known as the "*Split Bypass"* configuration. This is the standard configuration for all 1PH Models

In the "*Split Bypass*" configuration the static bypass line is switched by a separate isolator to a dedicated 'Bypass' power source which also feeds the maintenance bypass line.

The power switch locations in the various 7400 models are shown in Figure 3.

With the exception of the maintenance bypass isolator, all the isolators shown must be closed during normal UPS operation.

Although it cannot be classified as a 'power', the reset switch may be used as a part of the UPS operating procedure. Fitted to the UPS Logic Board, the reset switch is used by the operator to re-transfer the load to the inverter following a detected overload or overtemperature fault.

1.2.5 Battery Circuit Breaker

The battery is connected to the DC Busbar through a circuit breaker fitted inside the battery Cabinet / Rack or located adjacent to the batteries where a battery Cabinet / Rack is not used. This circuit breaker is closed manually, but it contains an undervoltage release coil which enables it to be tripped from the UPS control electronics following certain detects for faults. It also has a magnetic trip facility for overload protection.

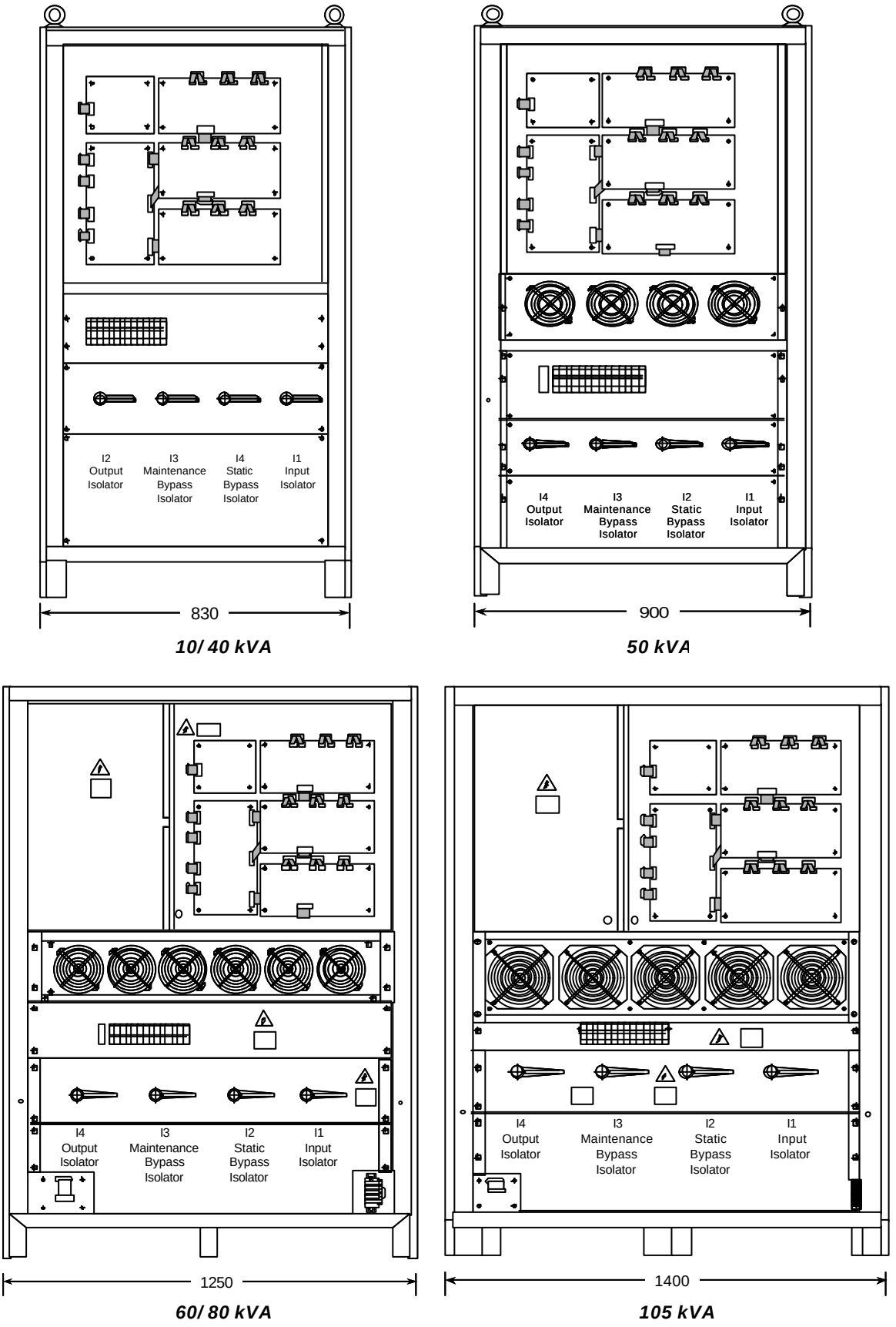


Figure 3A: Power Isolator identification for 230V output system

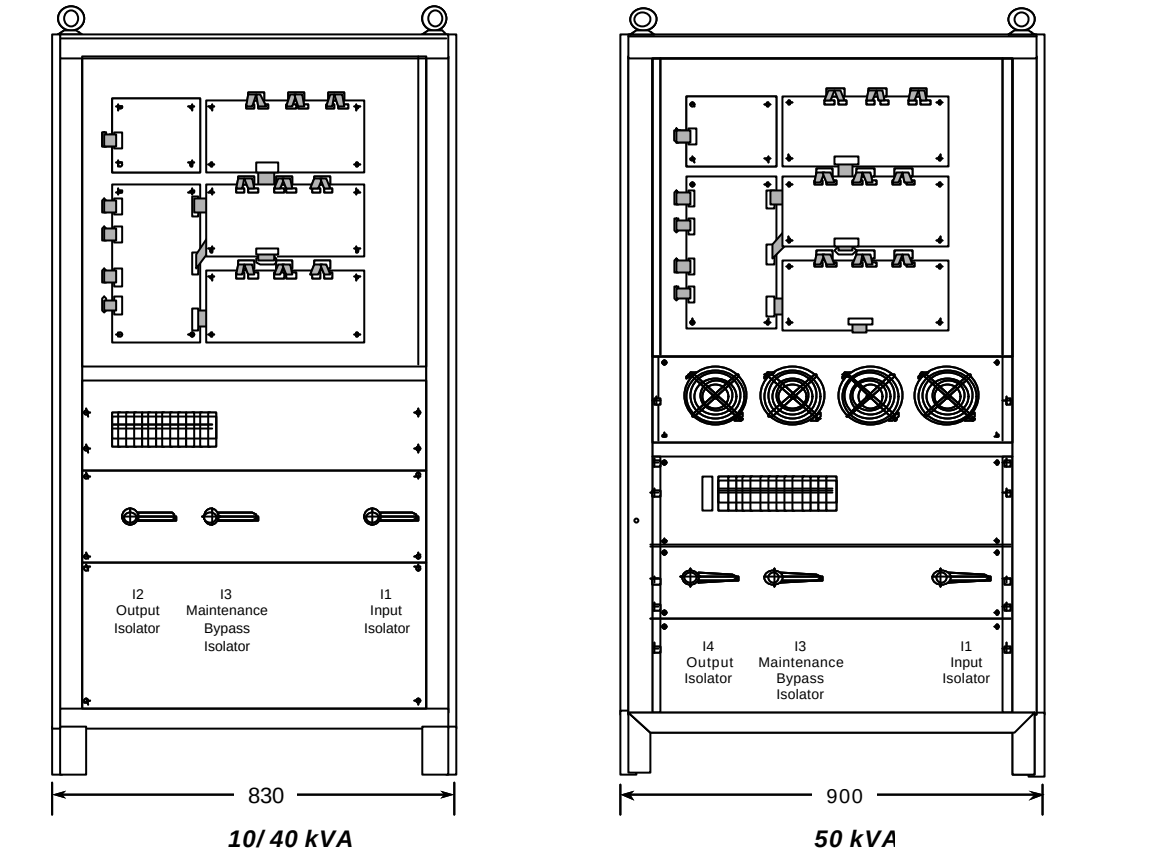


Figure 3B: Power Isolator identification for 110V output system

1.2.6 One plus One Parallel Control

When two of the standard 7400 modules just described are connected together to form a *one-plus-one* system, each module is fitted with an additional circuit board which allows the two modules to communicate with each other. Communication takes place via a single ribbon cable connected between the modules as illustrated in figure 4.

***Note**: - Modifying a standard module for use with a one-plus-one system also involves replacing certain other circuit boards with modified versions, and relocating certain minor assemblies. This means that although it is not impossible to modify an existing 7400 module to form part of a one-plus-one system it is not a straightforward proposition.*

The inter-module parallel control responsibilities are complex but can be summarised as follows:

Synchronisation:
As the outputs from both UPS modules are connected together to provide a single load supply, it is imperative that the inverters are fully synchronised both in frequency and phase. This is achieved by digitally locking the two inverter control oscillators. Similarly, as has already been mentioned, it is necessary for the inverters to be synchronised to the bypass supply to enable a "no-break" transfer to be achieved when the static switch transfers the load to the bypass supply. The inverter control oscillators are therefore not only locked together but are also made to track the bypass frequency.

Current sharing:
The parallel control circuit compares the module's output current with that of its partner and is thereby able to effect current sharing between the modules by making fine adjustments of an individual module's output voltage.

Redundancy configuration:
A link in the parallel control logic determines whether the *one-plus-one* system operates in a "redundant" or "non-redundant" configuration. If a non-redundant mode is selected the two static switch sections are effectively locked together in that both the static switches are turned off or on by a single control signal. Thus if one module develops a fault, when running, its static switch control logic will transfer its output from the inverter to the static bypass line and simultaneously send a signal to the static switch control logic in the second module to do likewise. This does not happen if the system is configured as a redundant system, in which case the second module is allowed to continue supplying the load from its inverter when the first module trips its inverter off line.

Reverse current:
A reverse current monitor circuit detects current flowing into, rather than out of, the module's output terminals. Such a condition can arise if a module develops an internal power fault or if for some reason the two modules become unbalanced, and is liable to further damage the module and also degrade the load supply. If a reverse current is detected the inverter on the affected module is immediately shut down and load transferred to the bypass supply depending on the system redundancy configuration.

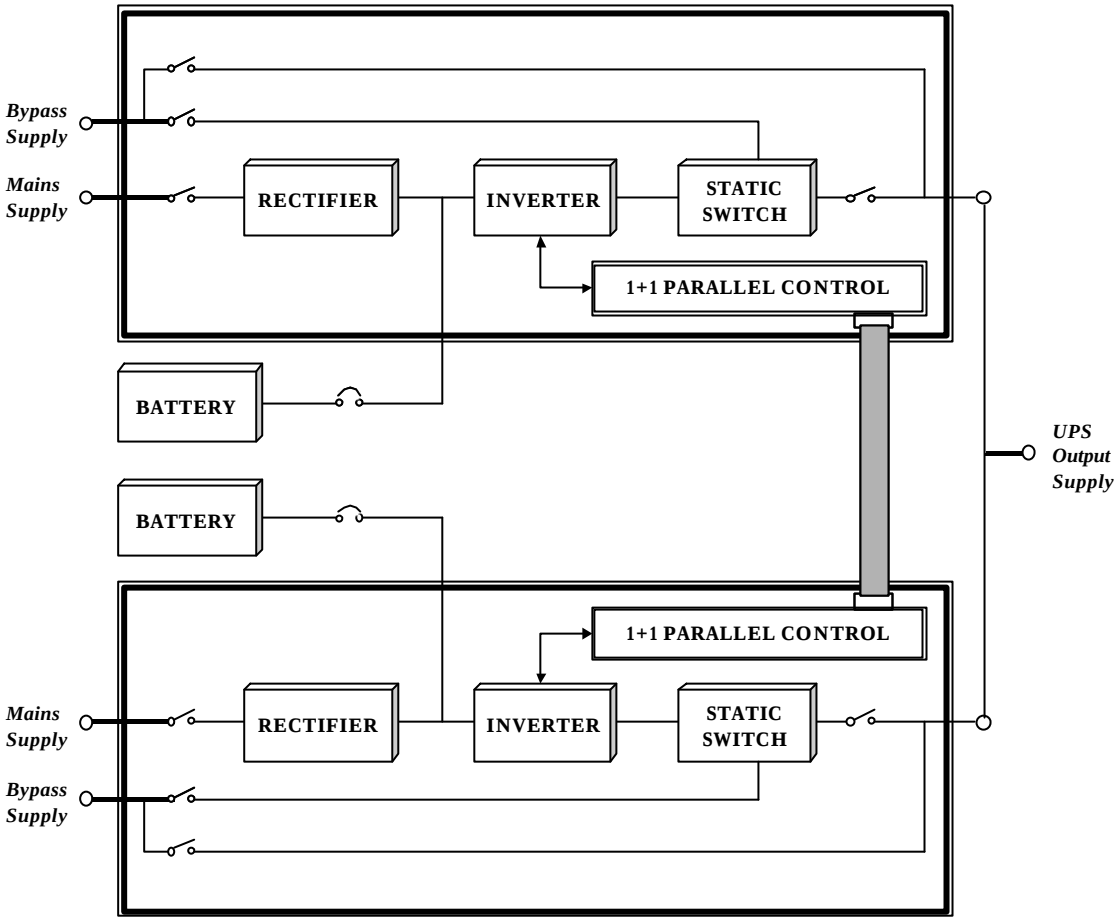


Figure 4: Parallel control in a one-plus-one system

Battery charge current sharing:
The illustration in figure 4 shows a dedicated battery installation for each module; however, it is possible to fit an option kit which allows the two modules in a *one-plus-one* system to share a common battery. Such an installation is shown in figure 5 overleaf.

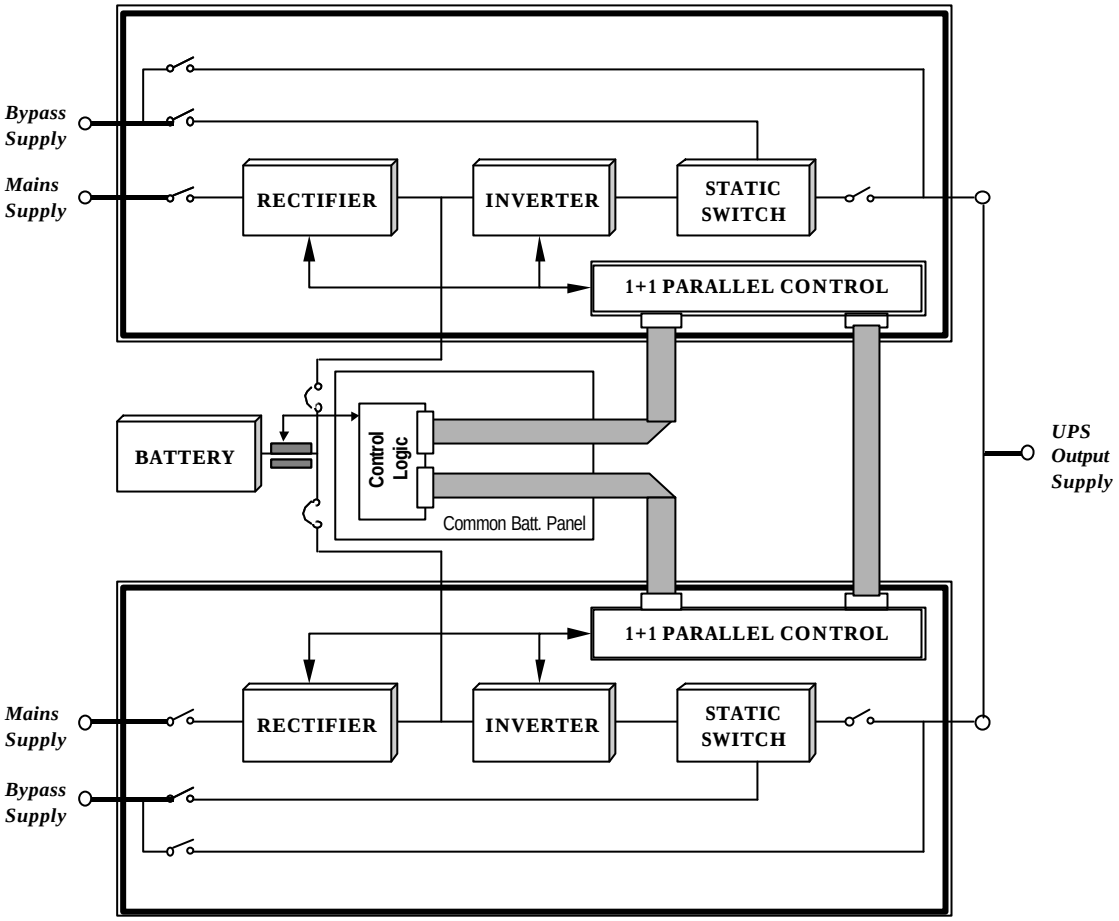


Figure 5: 'Common Battery' configuration

1.2.7 Common Battery

A "Common battery" option kit contains a DCCT (DC Current Transformers) which are fitted to the battery power lines and monitored by the parallel control logic. Each module monitors its battery charge current and compares it with the charge current provided by the other module. This enables a module to match its charge current to that of its partner by effecting fine voltage control over the rectifier section.

The components used by the Common Battery Option are contained in a separate cabinet known as the Common Battery Panel.

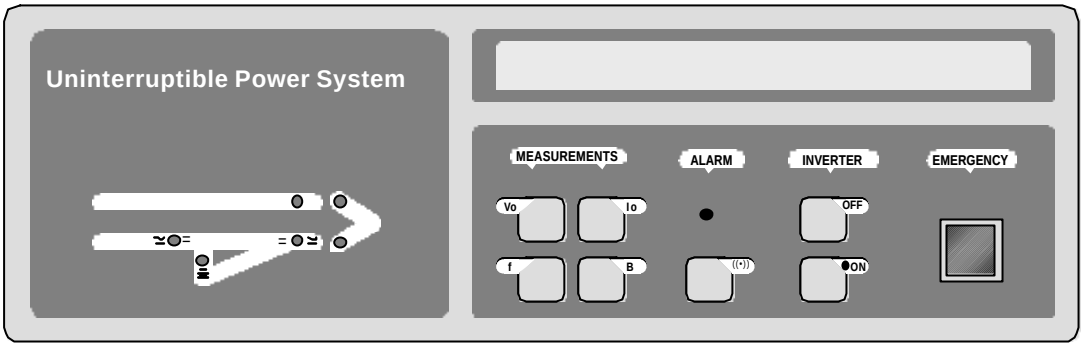


Figure 6: Operator Control Panel

1.2.8 Operator Control Panel

The operator control panel is divided into three functional areas; *'Mimic indications', Control switches'*, and *'LCD display panel'.*

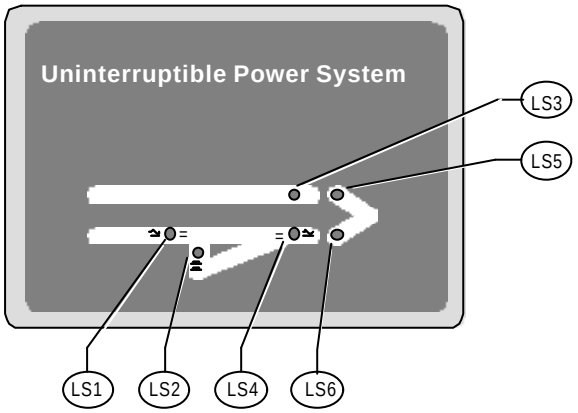


Figure 7: Mimic Panel

Mimic Indications

Six LEDs are mounted on a single line diagram to represent the various UPS power paths. These LEDs, which are annotated in figure7, show the current UPS operational status and should be interpreted as detailed below.

LSI - Input supply OK / Rectifier operative:

This led illuminates when the input isolator (I1) is closed, the input supply is within 20% of nominal voltage, and the rectifier is operative.

LS2 - Battery volts OK:

This led illuminates when the battery circuit breaker is closed and the battery voltage is within the UPS operating range - 320V-432V nominal. (330V - 445V* nominal for the 80 to 125 kVA Models).

LS3 - Bypass supply OK:

This led illuminates when the static bypass supply in within 10% of its nominal voltage and the static bypass isolator is closed.

LS4 - Inverter-output OK:

This led illuminates when the inverter is operating and its output is within a preset acceptable voltage window.

* - In case of battery on boost, this voltage can go upto 475V.

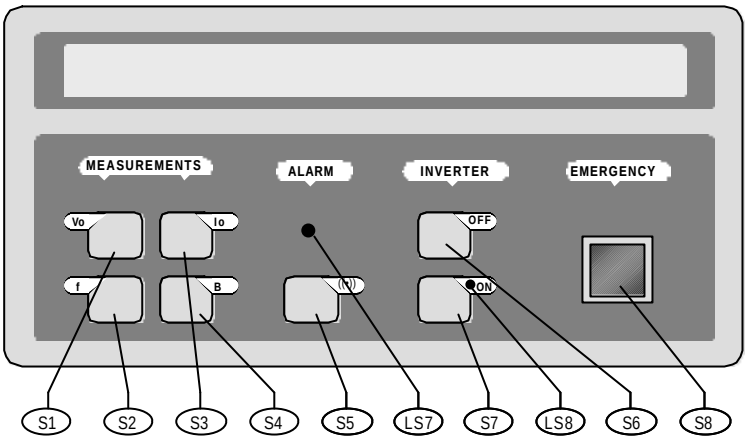


Figure 8: Control Panel Switches

LS5 - Load on bypass:
This led illuminates when the output isolator is closed and the load is connected to the bypass via the static switch.

LS6 - Load on Inverter:
This led illuminates when the output isolator is closed and the load is connected to the inverter via the static switch.

Control switches
Seven tactile switches are located on the Operator Panel, together with an emergency stop push button which is fitted with a safety cover to prevent inadvertent operation.

Switch S1 (Vo) - Output volts:
When this switch is pressed, the lower line of the LCD Display shows the output phase voltage w.r.t neutral.

Switch S2 (Fo) - Output frequency:
When this switch is pressed, the lower line of the LCD Display shows the output frequency.

Switch S3 (Io) - Output current:
When this switch is pressed, the lower line of the LCD Display shows the output current.

Switch S4 (B) - Battery:
When this switch is pressed, the lower line of the LCD Display shows the battery voltage and current. Note that a discharging current is symbolised by a preceding minus (-) sign, plus autonomy time is displayed according to % load for SMF batteries.

Switch S5 ((·)) - Alarm reset:
Pressing this switch cancels the audible alarm. The alarm led and messages will remain active if a detected fault condition is still present.

Switch S6 - Inverter OFF:
Pressing this switch turns OFF the inverter and causes the load to be transferred to the static bypass supply.

Switch S7 - Inverter ON:
Pressing this switch activates the inverter and causes the load to be transferred to the inverter side of the static switch after the inverter voltage has had time to stabilise.

Switch S8- Emergency Stop:
When the emergency stop switch is pressed it disables the static switch block entirely (so removing load power). It also disables the rectifier and inverter, and trips the battery circuit breaker. Under normal circumstances it does not remove UPS input power since this is applied through a manually controller isolator; however, if the UPS input supply is connected via a circuit breaker having an electrical trip facility the emergency stop signal can be used to drive the external circuit breaker's trip circuit.

There are two LEDs contained within the switch panel area:

LS7 Alarm:
This led accompanies the audible alarm warning when any alarm condition is initiated. The audible warning can be cancelled by the reset switch (S5) but LS7 will only extinguish after the alarmed condition has reverted to normal.

LS8 - Inverter status:
This green led situated near the inverter ON switch illuminates when the inverter is selected ON.

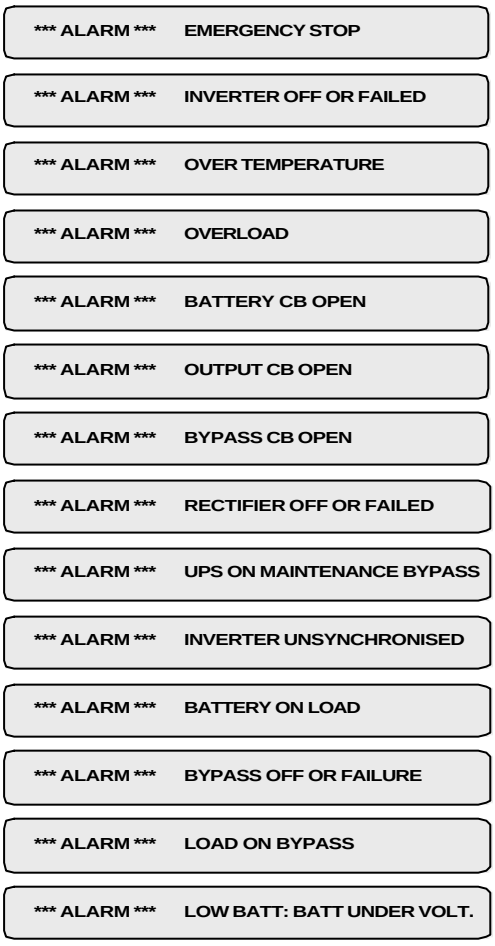


Figure 9: Display messages

LCD Display

An LCD display, capable of showing two rows of 40 characters, is used to indicate the UPS operating parameters, warnings and alarms.

A DIP switch fitted to the display microprocessor board enables the displayed language to be easily selected to English, French, Italian, Spanish or German.

The lower row of characters are used to display metered parameters; which include output (or bypass) voltage, frequency, or current together with battery current & voltage and autonomy time for SMF batteries only.

Warning and alarm messages are displayed on the upper row of characters. The ALARM led and audible warning accompany all *alarm* messages but are not activated by *warning* messages. In all cases, the message automatically resets when the alarmed (or warning) condition reverts to normal.

When two (or more) alarm or warning conditions are active simultaneously, the appropriate messages are displayed in a cyclic fashion, with each message appearing on the display for approximately for 10 seconds.

1.2.9 Battery Circuit Breaker

For all kVA Models battery circuit breaker can be provided either in auxiliary cubicle or in a separate box. This box is designed to be wall mounted and is connected between the UPS and battery bank.

1.2.10 Battery Cabinet / Rack

The batteries associated with the UPS are generally housed in a purpose built cabinet / rack located alongside, but not attached to the main UPS equipment.

It is possible to install batteries of various types and capacities in the cabinet / rack to obtain required autonomy characteristics.

1.3 Safety Precautions

1.3.1 General

In common with other types of high power equipment, dangerous voltages are present within the UPS and battery enclosure. The risk of contact with these voltages is minimised as the live component parts are housed behind a hinged, lockable door. Further internal safety screens make the equipment protected to IP20 standards. No risk exists to any personnel when operating the equipment in the normal manner, following the recommended operating procedures.

All equipment maintenance and servicing procedures involve internal access and should be carried only by trained personnel.

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When the battery is charge it is earth-referenced about it is mid-point -e.g. if the battery is being charged at 432V the battery extremities will be at +216V and - 216V with respect to neutral (earth). When using mains-powered test equipment such as oscilloscopes in the UPS high voltage area, always use a *differential* mode of operation to avoid the need to disconnect the oscilloscope frame earth.

1.3.4 Personnel

When working inside the UPS (trained personnel only) it is recommended that protection be worn to prevent eye damage, should an electrical arc be struck by mishandling or severe electrical fault.

Some of the power components are very heavy. If their removal is necessary ensure that sufficient manpower is available, otherwise use adequate mechanical handling equipment.

When working in the general area of the UPS where high voltages are present, a second person should be standing-by to assist and summon help in case of accident.

Chapter 2
Operating Instructions

2.1 Introduction

Starting and stopping the *one-plus-one* system is straightforward, however the modules' response depends on whether it is configured as a Redundant or Non-Redundant system. The operating procedures are the same irrespective of the selected redundancy mode; in simple terms you start (stop) one module and then repeat the operation on the second module.

The difference in the system response concerns the point at which the load is transferred between the bypass and uninterruptible (i.e. inverter) supplies and is summarised below: -

2.1.1 Redundant Module System

Starting:
When starting a redundant module system the load is transferred from the bypass to the inverter of the first module as soon as the first module is started and its inverter is brought on line. When the second module is started its static bypass line is totally inhibited due to the first module being on line, and the second module will not be connected to the load until its inverter is operational and fully synchronised with the first module.

Stopping:
When the first module is stopped its static bypass is inhibited because the load will be fully maintained by the inverter of the second module. When shutting down the second module, the static bypass lines of both modules will be turned on as soon as its inverter is stopped. That is, both modules will provide load power through their paralleled bypass lines.

2.1.2 Non - Redundant Module System

Starting:
In a Non-Redundant module system both modules must be running before the load is transferred to their paralleled inverters. Therefore when the first module is started the load will remain connected to its static bypass line.

Stopping:
The load will be transferred to the static bypass lines in both modules simultaneously as soon as the inverter stops in the first module to be shut down.

2.1.3 General Notes

Note 1: *All the user controls and indicators mentioned these in these procedures are identified in chapter 1.*

Note 2: *The audible alarm may annunicate at various points in these procedures. It can be cancelled at any time by pressing the 'Alarm Reset' pushbutton.*

Note 3: *The 7400 series UPS incorporates an optional automatic boost charge facility which can be used in systems containing non-sealed lead-acid batteries. If this type of battery is used in your installation you may notice that the battery charger voltage will be greater than its nominal 432Vdc when the mains supply returns from a prolonged outage. This is the normal response of the boost charge facility: the charger voltage should return to normal after a few hours.*

How to turn ON the System from a Shut down condition
(Complete this actions on one module at a time)

This procedure should be followed when turning on the *one-plus-one* system from a fully powered down condition - i.e. where the load is not being initially supplied through the internal Maintenance Bypass supply.

Step	Action	Response
1.	Close the module's Output Isolator and check that the UPS input mains supply (and bypass supply if separate) is turned on externally.	
2.	Close the input Isolator (and Static Bypass Isolator, if separate).	Mimic panel LEDs LS1 LS3 and LS5 should illuminate immediately, to indicate that the load is being supplied through the static bypass line. (*Note: In a Redundant Module system LS5 will not illuminate on the second module to be started as its static bypass line is inhibited).* The inverter should start automatically once the DC Busbar reaches its working voltage (after about 30 seconds), and when this occurs LS4 (inverter OK) will illuminate followed by LS6 (load on inverter). (*Note: In a Non-Redundant module system LS6 will not illuminate on the first module to be started until you reach this point in starting the second module.)* Note that LS5 will extinguish when LS6 illuminates.
3.	Wait 20 seconds then close the battery circuit breaker: This is located inside the battery cabinet (if used) or is otherwise located adjacent to the battery racks	Mimic panel LED LS2 should illuminate and LS7 (alarm) should extinguish.
4.	Press the battery metering selector switch [B].	The display should indicate a positive (+) battery charging current.

How to turn ON the System from a Maint. power-down condition
(Complete this action on module at a time)

This procedure should be followed to start the *one-plus-one* from a MAINTENANCE power-down condition - i.e. where the load is being initially powered through the internal maintenance bypass supply.

Step	Action	Response
1.	Check that the UPS mains supply (and bypass supply, if separate) is turned on externally.	
2.	Close the input isolator (and static bypass isolator if separate. For 110V systems Static bypass isolator is mounted in auxiliary cubicles).	Mimic panel LEDs LS1 and LS3 should illuminate immediately, to indicate that the input and bypass supplies are healthy. Inverter will not turn ON unless output isolator is closed. Inverter will not turn ON for 1+1 configuration at this stage. Inverter will not turn ON at this stage with output isolator open if modules are in 1+1 configuration.
3.	Wait 20 seconds then close the battery circuit breaker.	Mimic panel LED LS2 should illuminate.
4.	Press the battery metering selector switch [B] (S4).	The display should indicate a positive (+) battery charging current.
5.	Press the Inverter OFF pushbutton (S6).	Mimic panel LED LS4 should extinguish
6.	Close the Output Isolator	Mimic panel LED LS5 should illuminate to indicate that load is connected to the static bypass line. *(Note: In a Redundant Module system LS5 will not illuminate on the second module to be started as its static bypass line is inhibited).*
7.	Open the Maintenance Bypass Isolator ***on both modules*** then Press the Inverter ON switch (S7) on both modules. *(Note: The inverters of both modules are inhibited if either modules' Maintenance Bypass Isolator is closed).*	Mimic panel LEDs LS4 (Inverter OK) and LS6 (Load on Inverter) should illuminate after approximately 30 seconds. *(NB: In a Non-Redundant Module system LS6 will not illuminate on the first module to be started until you reach this point in starting the second module).* LS5 should extinguish at the same time as LS6 illuminates. LS7 (alarm) should extinguish.

How to turn OFF the System but continue to provide Load power through the Maintenance Bypass

This procedure should be followed if *one-plus-one* is to be powered-down while continuing to supply load through the maintenance bypass line. Note that during this procedure the load will be unprotected against mains supply disturbances once the inverter(s) has been switched off.

Step	Action	Response
1.	Ensure that LS3 is illuminated on the mimic panels (indicating that the static bypass supply is healthy).	
2.	Press the Inverter OFF switch (S6) on both modules	Mimic panel LEDs LS4 and LS6 should extinguish on both modules and LS5 should illuminate to show that the load has been transferred to the static bypass line. *Note: On a redundant system both Inverter OFF switches (S6) must be operated before LS5 illuminates but in a non-redundant system the Inverter OFF switch must be pressed on one module only before LS5 illuminates. However, as the load is transferred to the static bypass, the second module should be turned OFF also.*
3.	Close the Maintenance Bypass Isolator on both modules.	Mimic panel LEDs - No change
4.	Open the Output Isolator on both modules.	Mimic panel LED LS5 should extinguish on both modules.
5.	On each module - Open the battery circuit breaker followed by the input Isolator (and Static Bypass Isolator if separate. For 110V systems Static bypass isolator is mounted in auxiliary cubicles).	All the operator panel led indications and messages should extinguish as the mains driven internal power supplies decay.
6.	Isolate the UPS input supply from the mains distribution panel to make the UPS safe for work to be carried out internally.	

WARNING

The following points will be live within the UPS:

- Bypass supply input terminals
- Maintenance Bypass Isolator switch
- Static Bypass Isolator Switch (if fitted)
- UPS output terminals

How to totally Power down the System

This procedure should be followed only if the *one-plus-one* AND LOAD are to be completely powered down.

Step	Action	Response
1.	Press the Inverter OFF switch (S6) on both modules.	Mimic panel LEDs - LS4 and LS6 should extinguish and LS5 should illuminate to show that the load has been transferred to the static bypass line. *(Note: In a Non- Redundant Module system LS5 and LS6 will also changeover on the second module)*
2.	Open the battery circuit breaker.	Mimic panel LEDs LS2 should extinguish.
3.	Open the input isolator (and static bypass isolator also. For 110V systems Static bypass isolator is mounted in auxiliary cubicles).	All the operator panel led indications and messages should extinguish as the mains driven internal power supplies decay.

IMPORTANT

The Maintenance Bypass Isolator may be operated at any time when the UPS is powered down to connect / disconnect each load to the raw maintenance bypass supply if required.

Emergency Stop

The emergency stop pushbutton is located behind a hinged safety shield to prevent inadvertent operation. When this switch is pressed both modules are electronically shut down and both battery circuit breakers are tripped. Power is removed from the critical load, but pressing the emergency stop pushbutton will not remove the modules' input mains supply unless an external contactor, controlled via the emergency stop pushbutton, is fitted in the mains supply line.

Chapter 3
Installation Procedure

3.1 Introduction

WARNING

Do not apply electrical power to the UPS equipment before the arrival of the commissioning engineer

WARNING

The UPS equipment should be installed by a qualified engineer in accordance with the information contained in this chapter and the drawing package shipped inside the UPS cabinet.

WARNING

BATTERY HAZARDS

- Special care should be taken when working with the batteries associated with this equipment. When connected together, the battery terminal voltage will exceed 400Vdc and is potentially lethal.
- Eye protection should be worn to prevent injury from accidental electrical arcs.
- If a 'sealed' battery leaks electrolyte, or is otherwise physically damaged, it should be placed in a container resistant to sulphuric acid and disposed of in accordance with local regulations.
- If electrolyte comes into contact with the skin, the affected area should be washed immediately.

This chapter contains information regarding the positioning and cabling of the *one-plus-one* UPS equipment and batteries.

Because every site has its peculiarities, it is not the aim of this chapter to provide step-by-step installation instructions, but to act as guide as to the general procedures and practices that should be observed by the installing engineer.

3.1.1 Equipment positioning and environmental considerations

The UPS cabinets can be moved by fork lift or crane. Fork lift apertures are provided in the sides of the base plate and are accessible after removing blanking covers fitted to the side panel ventilation grills. Roof - mounted eye- bolts are fitted to enable the cabinet to be crane-handled. These can be removed once the equipment has been finally positioned.

WARNING

- Ensure that the UPS weight is within the designated S.W.L. of any handling equipment. See the UPS specification for weight details.
- Do not move the battery cabinet with the batteries fitted.

The UPS module should be located in a cool, dry, clean-air environment with adequate ventilation to keep the ambient temperature within the specified operating range. If necessary, a system of extractor fans should be installed to aid cooling-air flow, and a suitable air filtration system used where the UPS is to operate in a dirty environment.

Cooling air flow

All the models in the 7400 range are forced-cooled with the aid of internal fans. Cooling air enters the module through ventilation grills located at the bottom of the front, back and side panels (and the door in the case of the 50, 60, 80, 105 & 120 kVA models) and exhausted through grills located in the equipment roof. When the equipment is located on a raised floor, and bottom cable entry is used, additional cooling air also enters the UPS via the floor void.

Clearances

To allow adequate cooling air flow, you should position the equipment with the following space around the back and sides.

- *25kVA-40kVA 1 PH Models* - 100mm required if the UPS is situated on a solid floor. No space required if situated on a raised floor.
- *50kVA-125kVA 1 PH Models* - 100mm required in all cases.

The UPS modules do not require back-access for maintenance servicing; but, where space permits, a clearance of approximately 4 feet (1.2 meters) will ease access to some component parts. Clearance around the front of the equipment should be sufficient to enable free passage of personnel with the door fully opened.

3.1.2 Raised Floor Installation

If the equipment is to be located on a raised floor it should be mounted on a pedestal suitably designed to accept the equipment point loading. The installation diagrams in the back of this manual identifies the location of the holes in the base plate through which the equipment can be bolted to the floor.

3.1.3 Battery Location

In 25kVA to 125 kVA module installations the batteries associated with the UPS equipment are usually contained in a purpose-built battery cabinet/ rack which sits alongside the main UPS equipment. Sealed, maintenance-free batteries are normally used in this type of installation.

Due to their increased capacity, the batteries associated with larger UPS installations are usually too big to be mounted in a single cabinet and are either rack mounted or fitted in multiple, or bespoke, battery cabinets. Such installations may utilise non-sealed lead acid cells, requiring regular attention and impose their own environmental requirements.

Pedestals are required for the battery cabinets when they are located on raised floors, in the same way as for the UPS cabinets.

Where battery racks are used, they should be sited and assembled in accordance with the battery manufacturer's recommendations. In general, batteries require a well ventilated, clean and dry environment at reasonable temperatures to obtain efficient battery operation.

Battery manufacturers' literature provide detailed safety measures to be observed when employing large battery banks and these should be studied and the proposed battery installation checked to verify compliance with the appropriate recommendations.

The batteries are connected to the UPS through a circuit breaker which is manually closed and electronically tripped via the UPS control circuitry. If the batteries are cabinet-mounted this circuit breaker is fitted within the cabinet; however, if the batteries are rack-mounted or otherwise located remote to the main UPS cabinet then the battery circuit breaker must be mounted as near as possible to the batteries themselves, and the power and control cables connected to the UPS using the most direct route possible. Emerson Network Power (India) Pvt. Ltd. offer a purpose-designed remote battery circuit breaker box, containing the circuit breaker and its necessary control board, as a standard option kit.

3.2 Preliminary Checks

Before you install the UPS hardware you should carry out the following preliminary checks:

1. Verify that the UPS room satisfies the environmental conditions stipulated in the equipment specification, paying particular attention to the ambient temperature and air exchange system.

2. Remove any packaging devices debris then visually examine the UPS and battery equipment for transit damage, both internally and externally. Report any such damage to the shipper immediately.

3. Verify that the shipment is complete -e.g. that the battery contains the correct number of cells etc. Report any discrepancy immediately.

4. When you are satisfied that the equipment is complete and in good condition move it to its proposed final position.

Note: *If 'side' cable entry is to be used ensure that the blanking plates are removed before finally fixing the cabinet position.*

5. All UPS models have a stabilising bar fitted to the output transformer T1 and input choke L1 during shipment. This should be removed when the UPS has been placed in its final position. Also PCB door is fixed with z-type clamps which should be removed.

CAUTION
Ensure the stabilising bar fitted to the output transformer T1 is removed before proceeding with the installation.
Ensure removal of z-type clamps used for fixing PCB door.

3.3 Connecting UPS Power Cables

WARNING

- Before cabling-up the UPS, ensure that you are aware of the location and operation of the external isolators that connect the UPS Input / Bypass supply to the mains distribution panel.
- Check that these supplies are electrically isolated and post any necessary warning signs to prevent their inadvertent operation.

3.3.1 Cable Entry

Cables can enter the UPS modules and battery cabinet either from below or through either side. Side entry is made possible by removing blanking pieces fitted in the side ventilation grills to reveal the cable entry holes. This cable entry method allows the equipment to be positioned on a solid floor without the need for cable trenching and also allows cables to pass from one module to the other when positioned side-by-side.

3.3.2 Cable Rating

When connected as a one-plus-one Non Redundant system, the UPS modules' input and output cables must be rated to suit the supported load rather than the individual module's power rating. This is due to the possibility of connecting the full load to the mains via the Maintenance Bypass line of one module.

In a Redundant system this is unnecessary as each module is individually rated to support the full load, and the input/output cables can be sized to suit the modules' rating according to the table given below.

UPS RATING	NOMINAL CURRENT (AMPS) 1 PH. UPS				
	INPUT MAINS		BYPASS/ OUTPUT		BATTERY
	380V	415V	110V	230V	
25	53	49	227	109	68
40	85	78	364	174	110
50	106	98	455	217	136
60	128	117	546	261	163
80	167	153	727	348	216
90	190	173	818	391	240
105	219	199	955	457	279
125	261	237	1136	544	331

3.3.3 Cable Connections

In the 25-40kVA UPS 1 PH models the input mains / bypass cables, UPS output cables and battery cables are connected to busbars located behind a safety cover just below the power isolator switches -as shown in figure 11. A terminal block is used for connecting the control cables to the battery circuit breaker and the external emergency stop facility.

For the 50 to 125 kVA 1PH models the power cables are connected either directly to their respective circuit breakers or to busbars, which are themselves, connected to the circuit breakers. See figure 12 – 14.

For 110V systems Static bypass isolator is located in auxiliary cubicles which is usually in scope of Emerson Network Power (India) Pvt. Ltd. Generally it is mounted in SCVS/ SVR cubicles. The cable connection details for the same are given in figures 15 – 18.

3.3.4 Cabling Procedure

Once the equipment has been finally positioned and secured, connect the power cables as described in the following procedure. Study the connection diagrams in figures 19 & 20 and positively identify the diagram relevant to your equipment before commencing cabling.

1. Verify that the UPS equipment is totally isolated from its external power source and all the UPS isolators are open.

2. On each module, connect the input supply cables between the mains distribution panel and the UPS input mains terminals.
   - ENSURE CORRECT PHASE ROTATION.

3. Connect the UPS bypass supply cables between the bypass distribution panel and the UPS bypass supply terminals on each module.

4. Connect the output terminals of both modules together (in parallel).
   - ENSURE CORRECT PHASE - PHASE CONNECTION (R - R & N - N).

   Then connect the UPS output cables between the paralleled UPS output terminals and load distribution panel.

   Note: *If the UPS is to be commissioned before the load equipment is ready to receive power then SAFELY isolate the load cables.*

5. On each module, connect the battery cables between the UPS battery terminals and its associated battery circuit breaker -see figures 19 & 20. As a safety precaution remove the battery fuse in the module until the arrival of the commissioning engineer.
   - OBSERVE THE BATTERY CABLE POLARITY.

WARNING
Do not attempt to close the Battery Circuit Breaker before the equipment has been commissioned

6. Connect the safety earth and any necessary bonding earth cables to the copper earth busbar located on the floor of the equipment below the power connections.

   Note:- *The earthing and neutral bonding arrangement must be in accordance with local and national codes of practice.*

7. Connect the battery circuit breaker control cables between the UPS auxiliary terminal block and battery circuit breaker controller board as shown in figures 19 & 20.

8. If an external emergency stop facility is to be used then remove the link between terminals 4 and 5 of the auxiliary terminal block and connect the 'normally closed' remote stop circuit between these two terminals.

   Note:- *Terminals 8 and 9 on the auxiliary terminal block are connected to a pair of 'normally closed' contacts on the UPS emergency stop button and will go open circuit when the emergency stop pushbutton is pressed. These terminals can be used to control an external circuit breaker connected in the UPS input mains supply line to isolate the UPS input power when the emergency stop button is pressed.*

9. Connect one-plus-one parallel control ribbon cables between the Parallel Interface boards of both modules. Connect one ribbon cable between sockets CN1 on one board and CN2 on the other, and connect the second ribbon cable between the remaining CN1 and CN2 sockets. Refer figure 10.

10. Maintenance bypass switch auxiliary wires at terminals 10 & 11 should be connected to other module terminals 10 & 11.

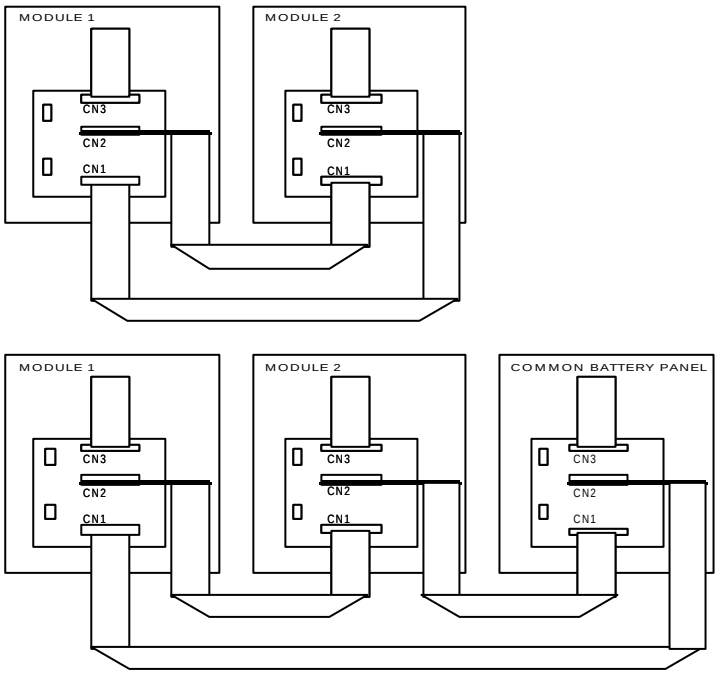


Figure 10: Connecting the parallel interface cables.

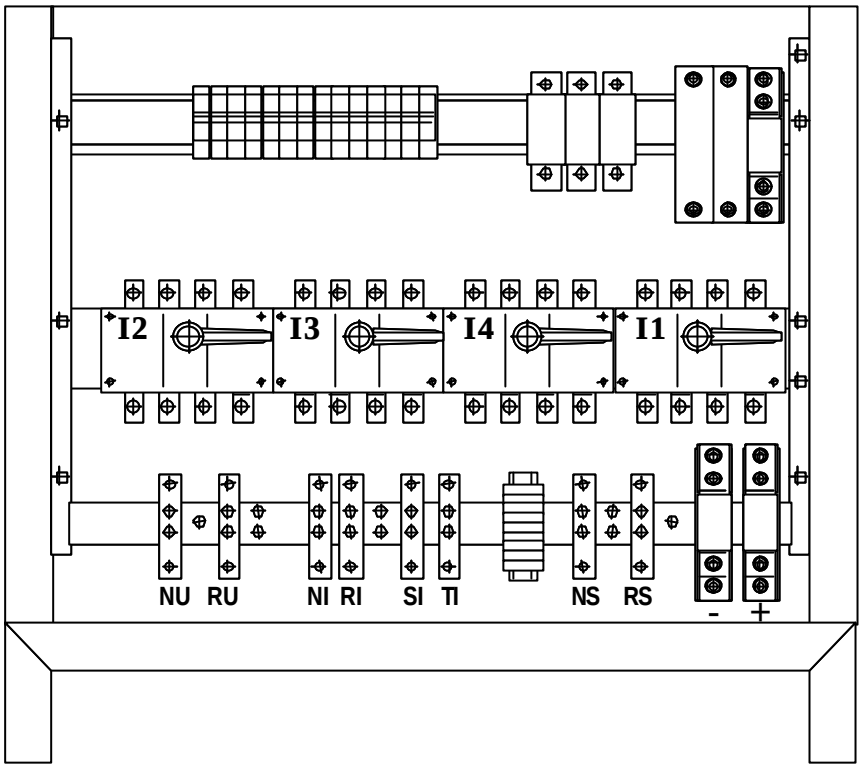


Figure 11: Cable connection 25-40kVA, 230V, 1 Ph.

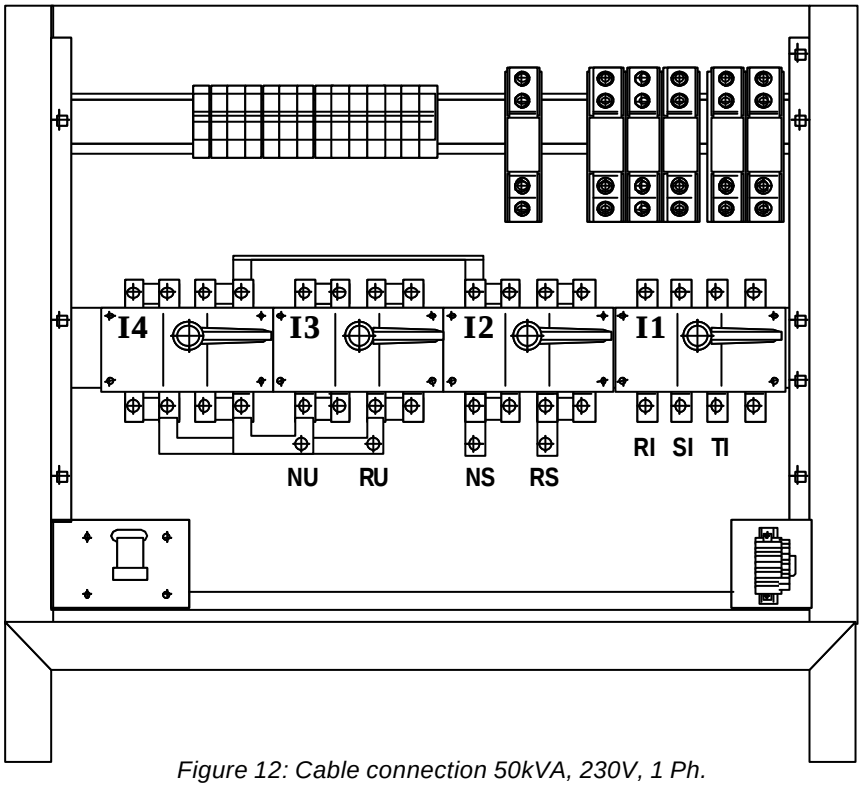


Figure 12: Cable connection 50kVA, 230V, 1 Ph.

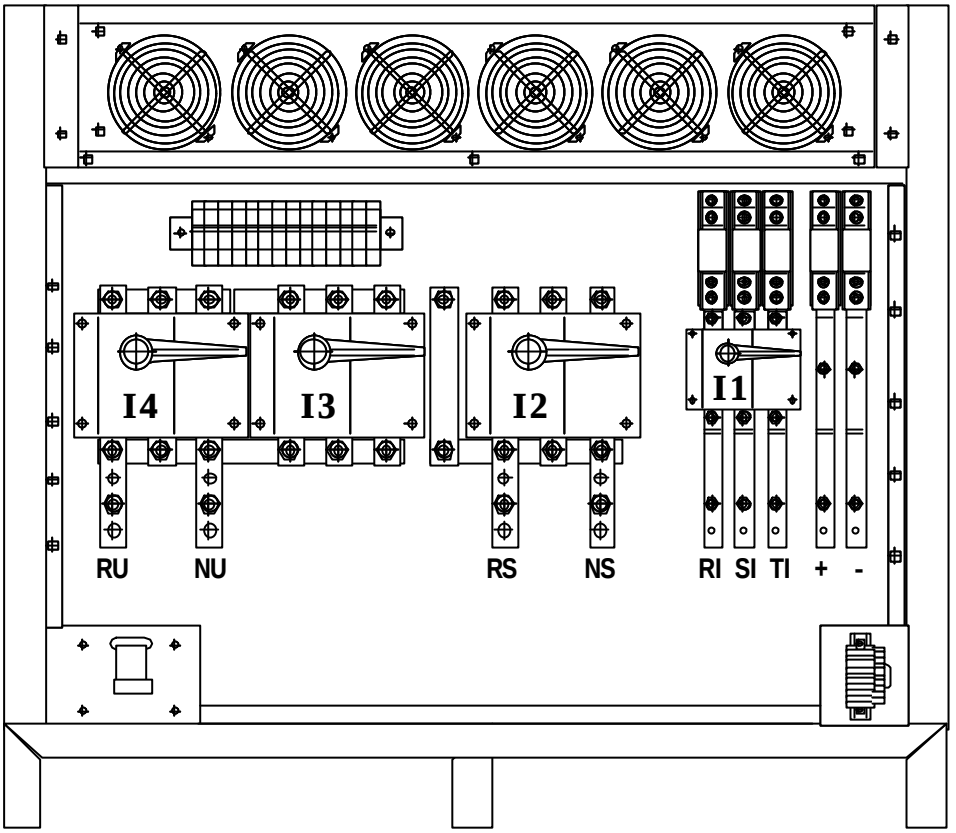


Figure 13: Cable connection 60 / 80 kVA, 230V, 1 Ph.

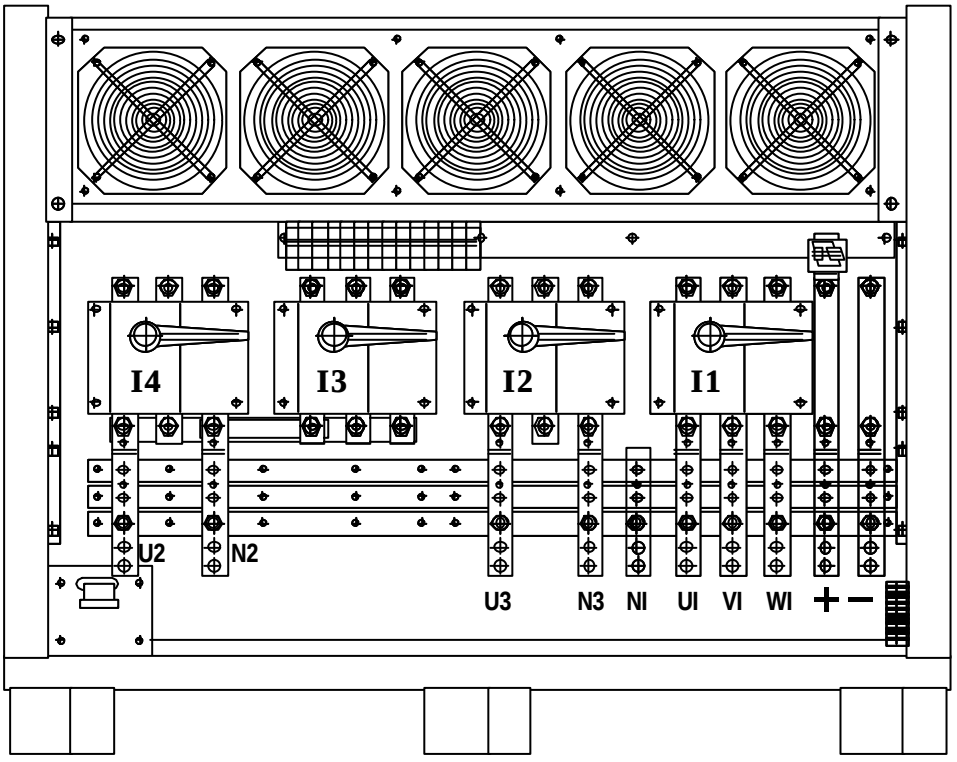


Figure 14: Cable connections for 105 kVA, 230V, 1 Ph.

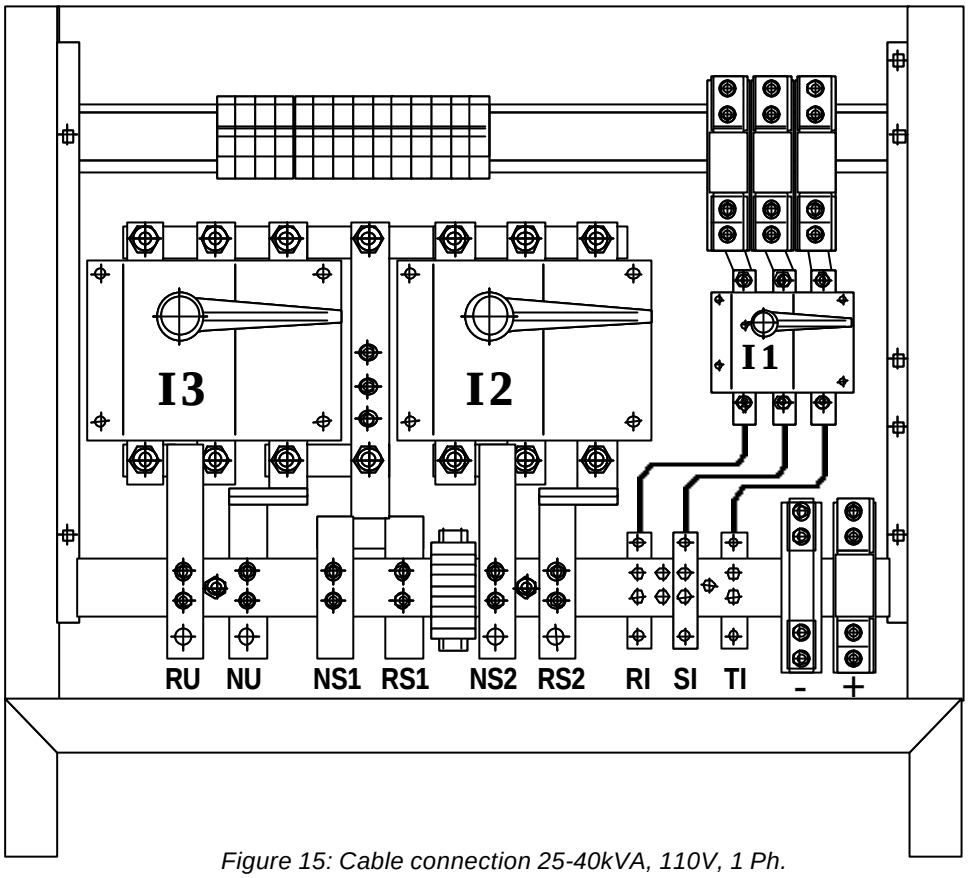


Figure 15: Cable connection 25-40kVA, 110V, 1 Ph.

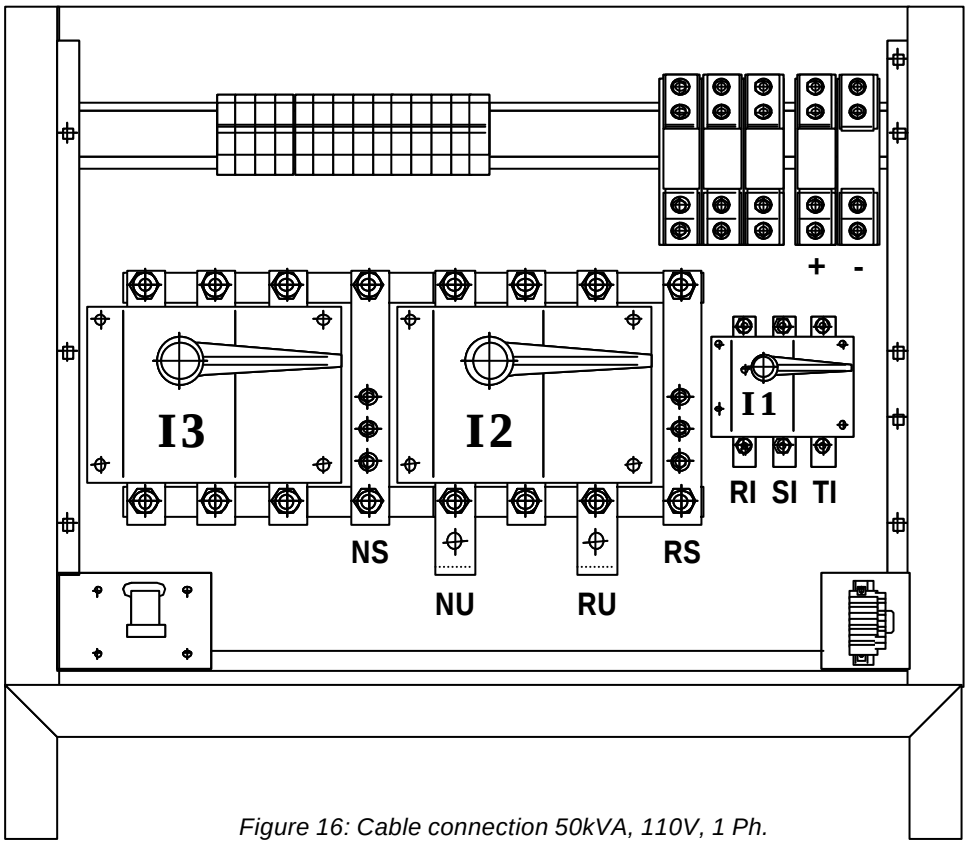


Figure 16: Cable connection 50kVA, 110V, 1 Ph.

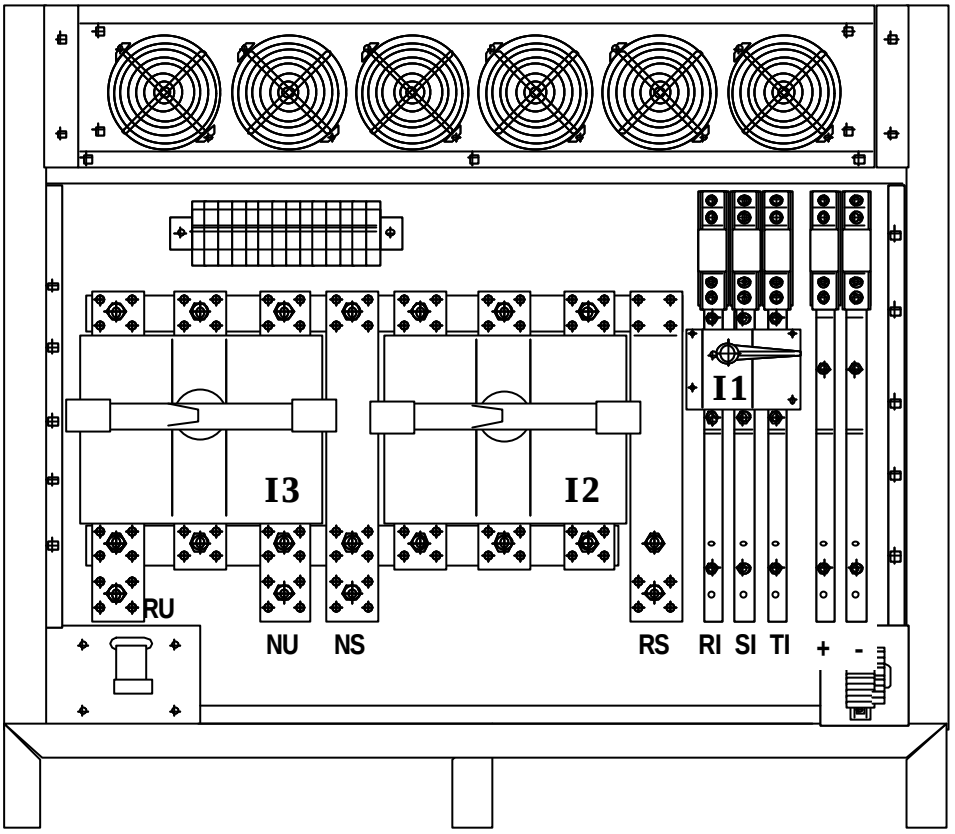


Figure 17: Cable connection 60 / 70 kVA, 110V, 1 Ph.

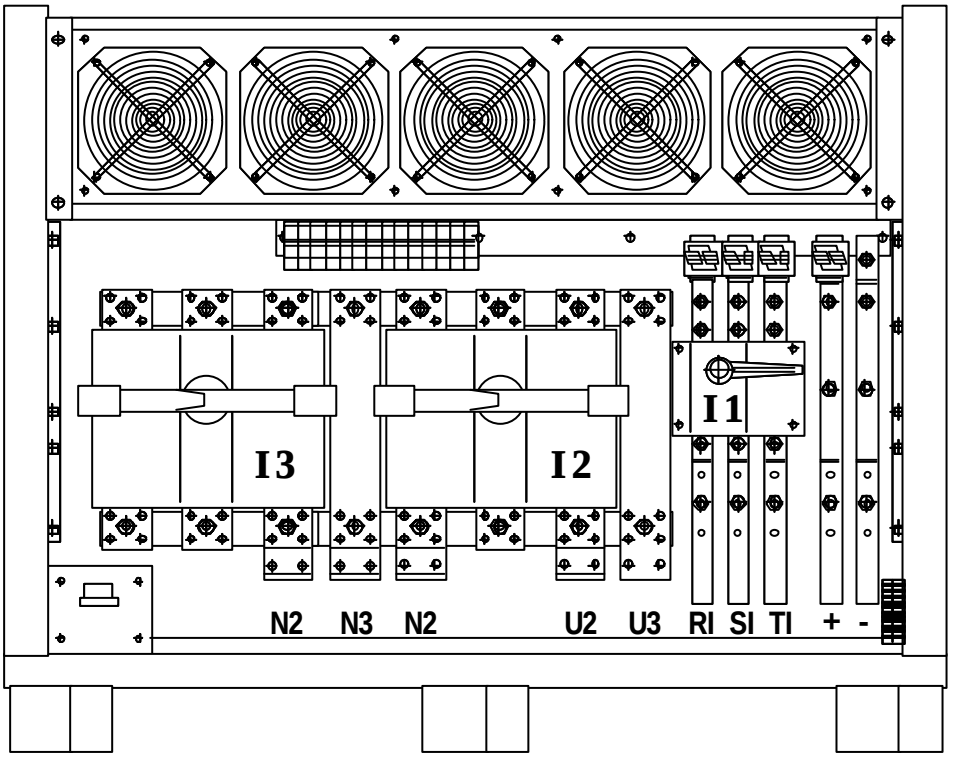


Figure 18: Cable connections for 105 kVA, 230V, 1 Ph.

3.5 Battery Circuit Breaker Boxes

A battery circuit breaker box houses the battery circuit breaker and its controller board and is used to connect the battery to the UPS in installations where the batteries are not contained in the standard battery cabinet. It is most likely used with 60–125 kVA UPS models.

Several boxes of various current ratings are available and are similar in their design and content. These are listed below :

100 Amp C.B. # 0120206014 for use with 25 – 40 kva models.
160 Amp C.B. # 0120206014 for use with 50 – 60 kva models.
250 Amp C.B. # 0120206014 for use with 80 kva models.
400 Amp C.B. # 0120206014 for use with 90 – 125 kva models.

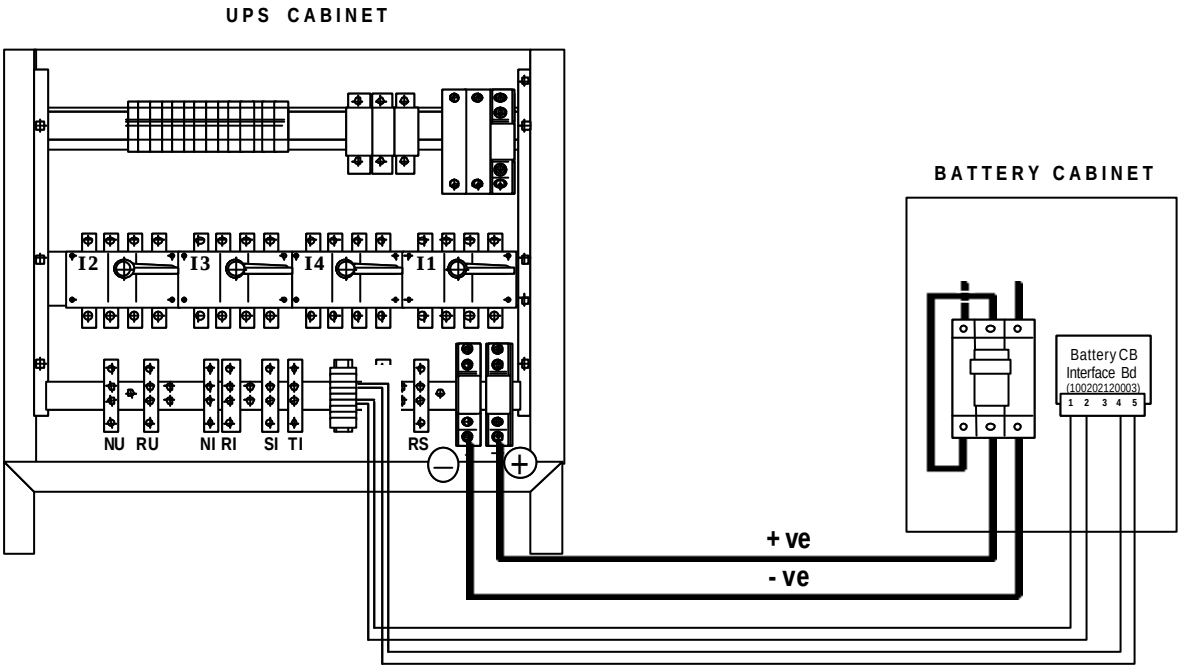


Figure 19: Battery C.B. box connections for 25-40kVA 1Ph UPS

Usually the 'box' is fitted as close as possible to the batteries. Figure 19 shows the details of the power and control cable connections between the circuit breaker box and UPS itself. These are similar to the connections made to the battery cabinet, previously described.

As a safety precaution, remove the battery fuse in the UPS before making the battery circuit breaker power connections.

***Note**: The polarity of the battery connections in the 25 - 40 kVA UPS cabinets are reversed for 50 - 125kVA UPS modules.*

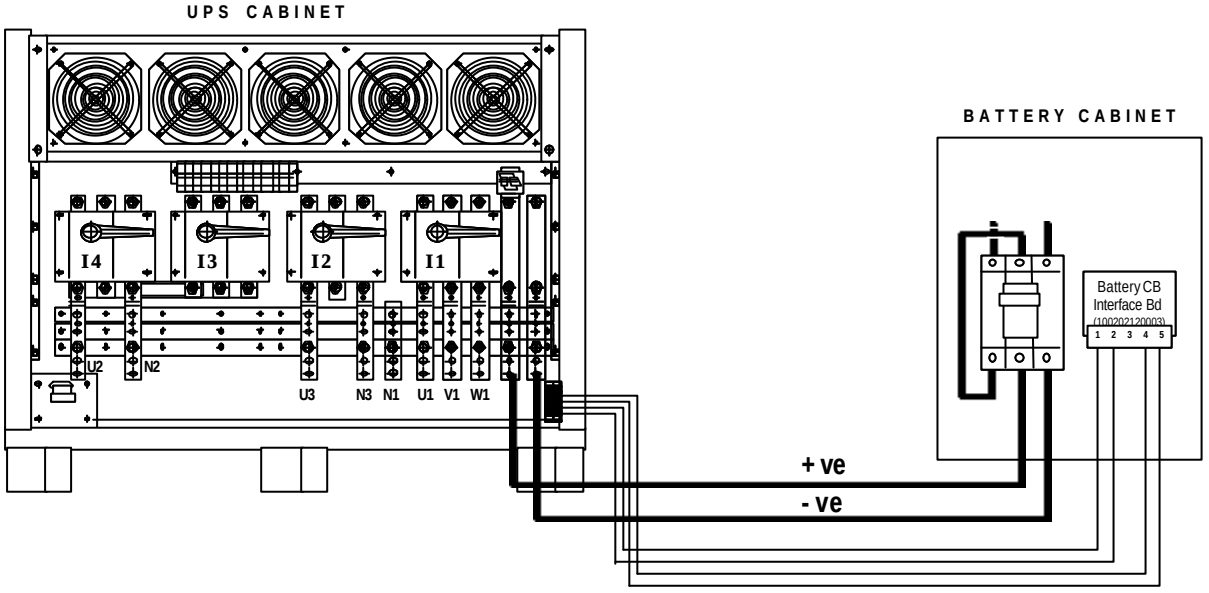


Figure 20: Battery C/B box connections for a typical 105 kVA 230V 1 PH UPS

Chapter 4

Optional Equipment

Several items of optional equipment are available for fitting to the 7400 series UPS for the use by the customer as required.

These options are:

- IBM AS400 Interface
- IBM AS400 Interface with 4-way output
- Output Interface Board
- Remote Alarms Board.
- Input filter

In addition to these options, it is possible for the customer to use an RS232 extension of the operator control panel (fitted as standard) for external indications.

4.1 AS400 Interface Board (#100215120003)

The AS400 Interface board connects the five most operationally critical UPS alarms to an IBM AS400 computer, which is designed to monitor such alarms and respond to their appearance:

* Mains failure
* Load on inverter
* Low battery and/or battery circuit breaker open
* Load on mains (bypass)
* Load on maintenance bypass

These alarm signals are provided by volt-free relay contacts.

The AS400 Interface Board is fitted to the bottom of the UPS cabinet door and connected to the UPS control electronics by a ribbon cable (FC17 in 25-40 kVA modules and FC13 in 50-125 kVA single phase modules) which is fitted to all modules and normally stowed in the cable loom when this option is not used.

4.1.1 AS400 Interface Board Outputs

Two D-type connectors are provided on the Interface Board to enable the above signals to be connected to the AS400 computer. One connector, CN1, has 9 pins and the other, CN2, has 15. Figure 21 provides pin-out details for these connectors.

***Note**: Use one connector only -i.e. don't use both connectors simultaneously.*

In addition to the D-type connectors, the AS400 Interface Board also contains a number of volt-free relays whose contacts provide a duplicate set of volt-free alarm outputs that are connected to terminal block M1 -as shown in figure 21. These outputs can be used to drive an external alarms monitoring device.

***Note**: When using the above contacts for remote alarm annunciation, the power supply for the remote indicators must be provided from an external power source. Under no circumstances should the UPS internal low voltage supplies be used for this purpose.*

4.1.2 Remote Control Inputs

The Interface Board has facilities to accept two remote control inputs, as shown in figure 21. One remote input allows the inverter to be shut down (transferring the load to the bypass supply) and the other enables the inverter synchronisation feature to be inhibited. This facility is valid only for single module. The inverter synchronisation inhibit feature is most often used if the UPS is powered from a standby generator when the input mains supply fails and the generator frequency is unstable.

The external control signals (12V/ 24V) should be connected to terminal block M2 as shown in figure 21. Once again, the voltage supplied to these terminals must be generated by an external power source and not taken from the UPS internal low voltage supplies.

4.1.3 Calibration

When fitting the AS400 interface board to the 7400 series, ensure that link SH - 1 is in position 1 - 2.

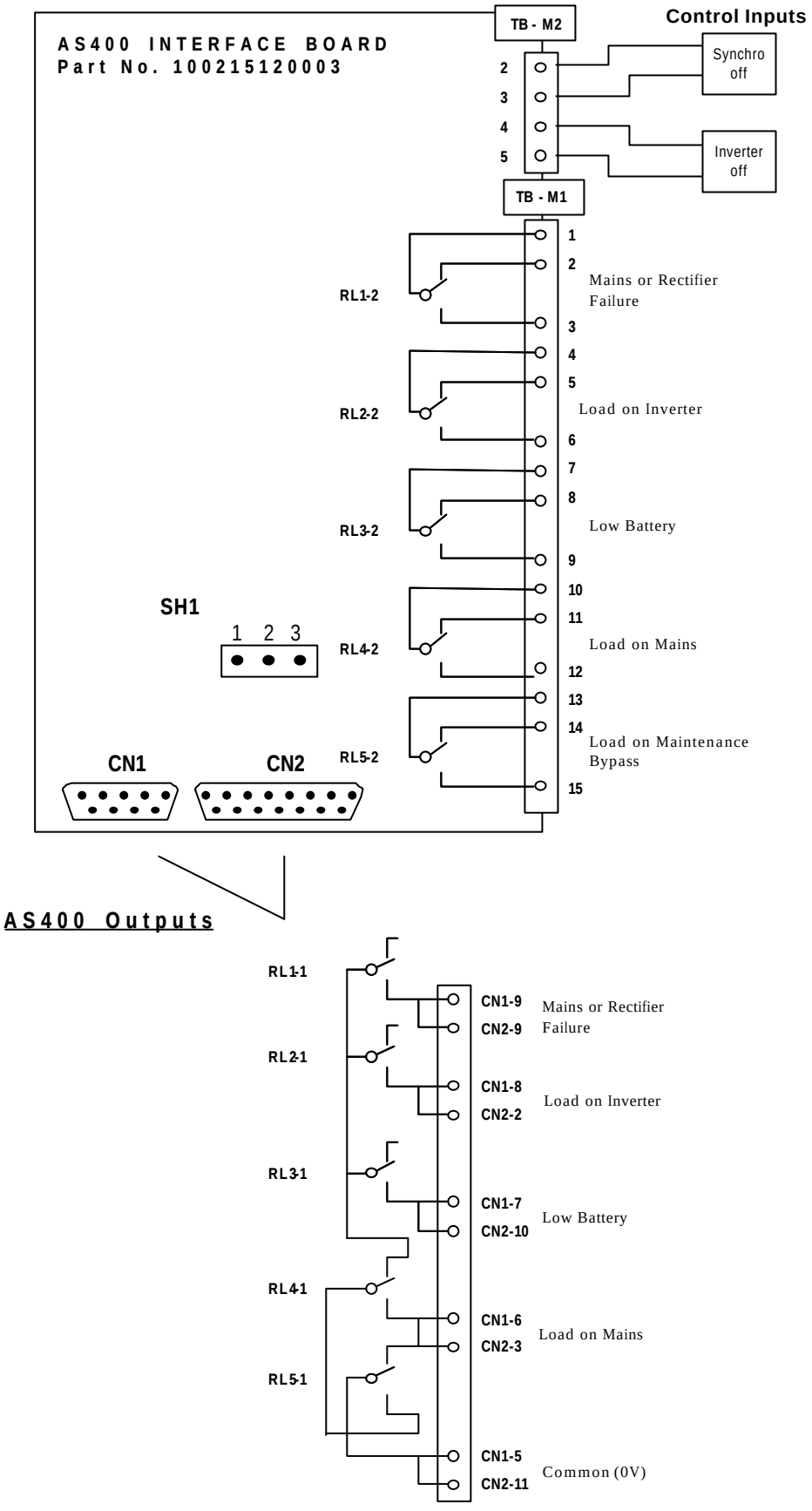


Figure 21: AS400 Interface Board Outputs

4.2 4-WAY AS400 Interface Board (#100201120004)

The 4-way AS-400 Interface board connects fiver critical UPS alarms to four output terminal blocks M1 - M4 as shown in figure 22. These alarm signals can be connected to a IBM AS 400 computer designed to monitor such alarms, or to a Remote Alarm Monitor panel.

The alarms monitored are:

* Mains failure
* Load on Inverter
* Low battery and / or battery circuit breaker
* Load on mains (bypass)
* Load on maintenance bypass

The signals commonly interfaced with the AS400 are:

- Mains failure
- Load on inverter or UPS ON
- Low battery

These alarm signals are provided by volt-free relay contacts.

Note: *When using the above contacts for remote alarm annuciation, the power supply for the remote indicators must be provided from an external power source. Under no circumstances should the UPS internal low voltage supplies be used for this purpose.*

The 4-way AS400 Interface Board is also positioned in the UPS cabinet (below the power isolators), and connected to the UPS control electronics by a ribbon cable (FC17 in 25-40 kVA modules and FC13 in 50-125k VA single phase modules) connected to CN1.

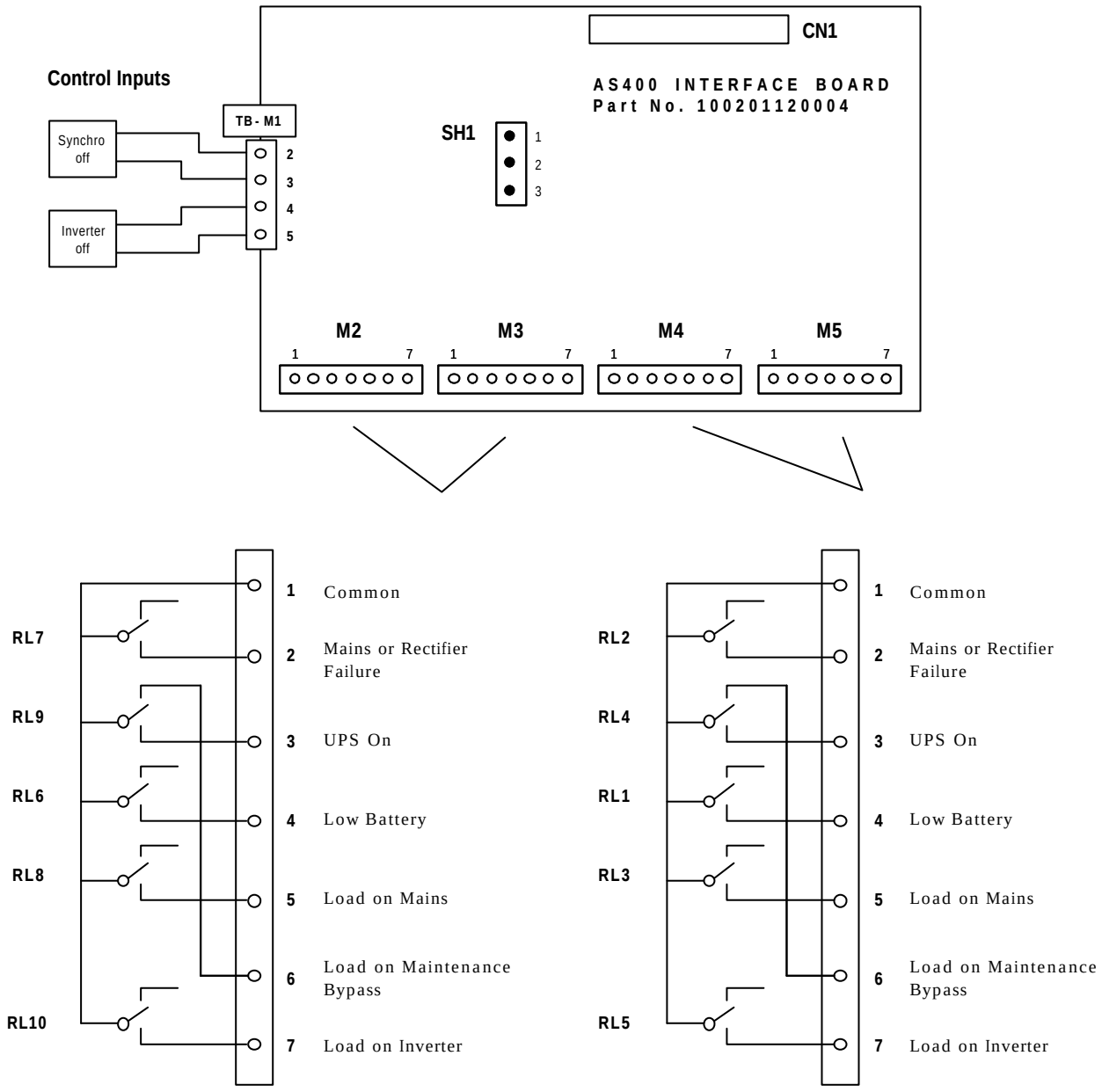
4.2.1 Remote Control Inputs

The Interface Board has facilities to accept two remote control inputs, as shown in figure 22. One remote input allows the inverter to be shut down (transferring the load to the bypass supply) and the other enables the inverter synchronisation feature to be inhibited. This facility is valid only for single module. The inverter synchronisation inhibit feature is most often used if the UPS is powered from a stand by generator when the input mains supply fails and the generator frequency is unstable.

The external control signals (12V / 24V) should be connected to the terminal block M1 as shown in figure 22. Once again, the voltage applied to these terminals must be generated by an external power source and not taken from the UPS internal low voltage supplies.

4.2.2 Calibration

When fitting the AS400 interface board to the 7400 series, ensure that link SH-1 is in position 1-2.



Outputs from M2 - M5 to Remote Alarm or AS400

Figure 22: Four output AS400 Interface Board

4.3 Output Interface (Remote Alarms) Board (100215120007 & 100215120002)

4.3.1 Alarm Outputs

Two remote alarm boards, shown in figure 23 & 24, similar in function and differing only in their connections to the terminal blocks M1 - M3, enable the alarm signals generated within the UPS to be connected by means of volt-free changeover relay contacts to a remote monitoring device.

Note: *When using the above contacts for remote alarm annunciation, the power supply for the remote indicators must be provided from an external power source. Under no circumstances should the UPS internal low voltage supplies be used for this purpose.*

4.3.2 Remote Control Inputs

Both board have facilities to accept two remote control inputs, as shown in figures 23 and 24. One remote input allows the inverter to be shut down (transferring the load to the bypass supply) and the other enables the inverter synchronisation feature to be inhibited. This facility is valid only for single module. The inverter synchronisation inhibit feature is most often used if the UPS is powered from a standby generator when the input mains supply fails and the generator frequency is unstable.

The external control signals (12V / 24V) should be connected to terminal block M2 as shown. Once again, the voltage applied to these terminals must be generated by an external power source and not taken from the UPS internal low voltage supplies.

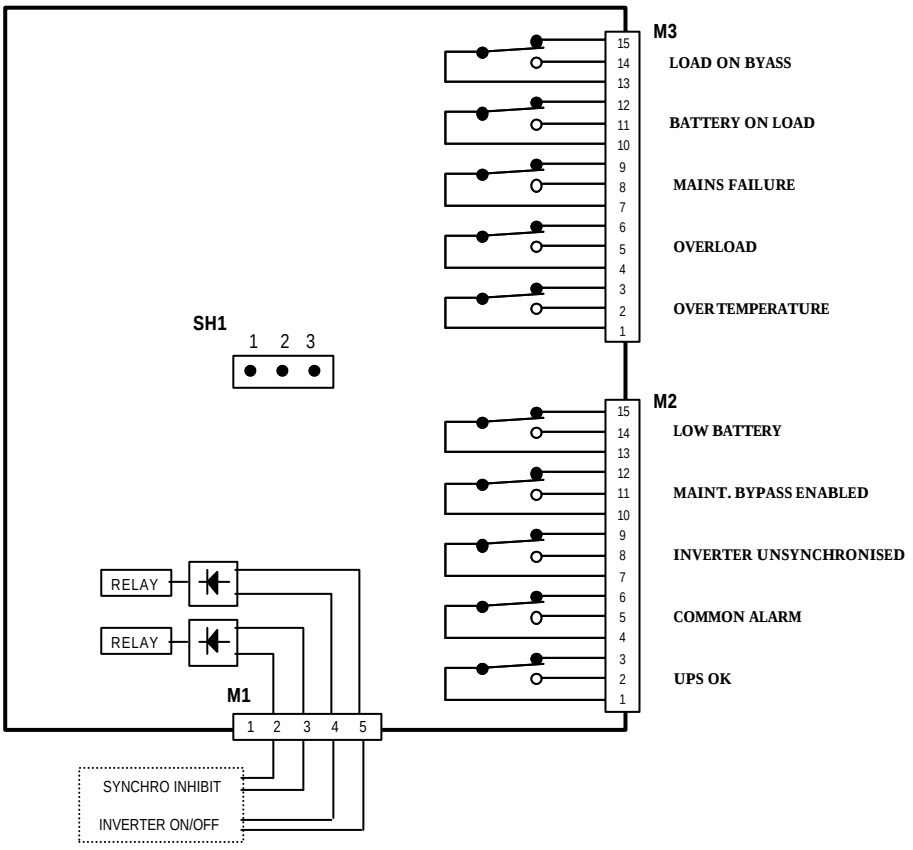


Figure 23: Output Interface Board #100215120007

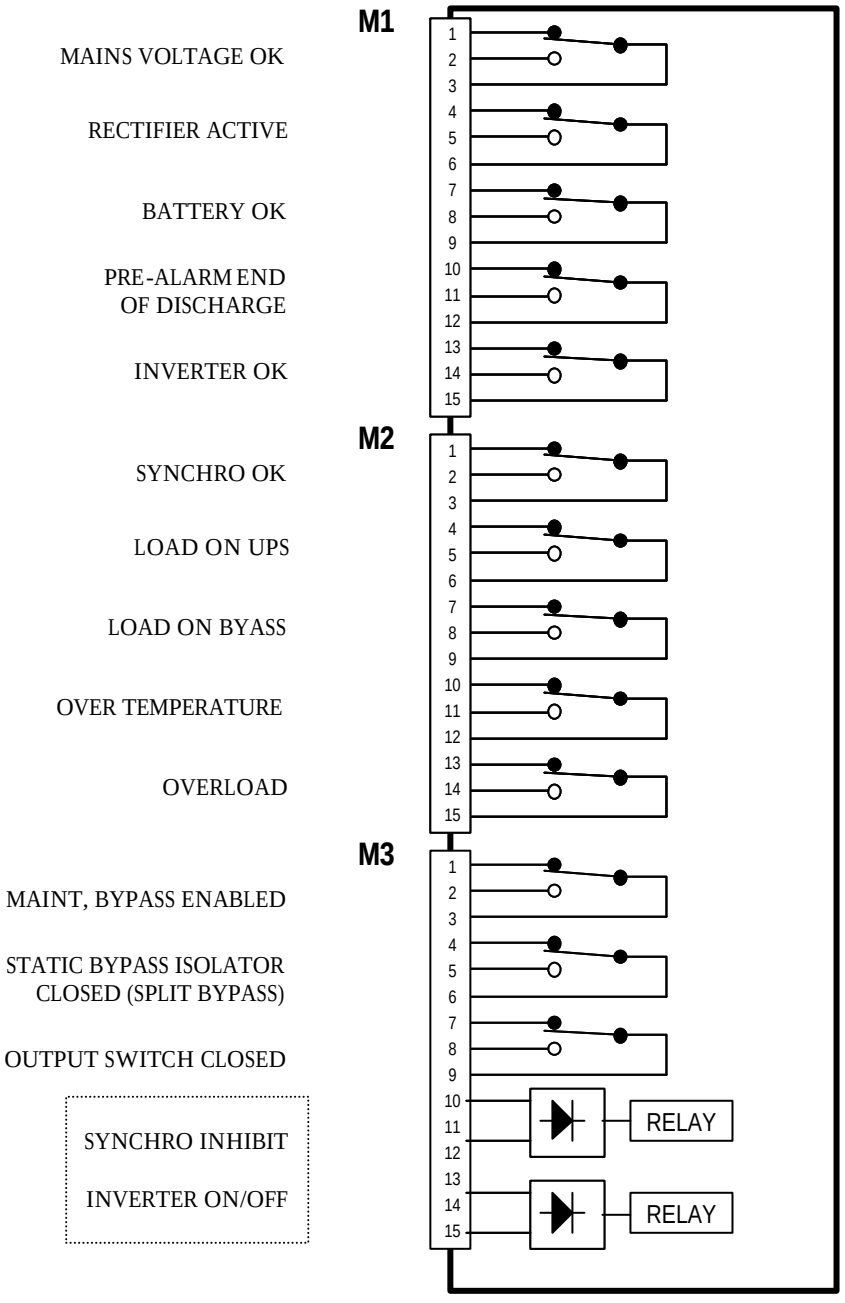


Figure 24: Output Interface Board #10021512002

4.4 Remote Alarm Monitor (RAM) for Single Module & "1 + 1" UPS System.

This will contain following items:

1. Remote Alarm Monitor for Single Module #270154000001.
2. Remote Alarm Monitor for 1+1 Module #270154000003.

This unit is always used in conjunction with Alarm interface PCB #100215120002, only. Remote Alarm Monitor enables the auxiliary alarm signals to be displayed at a remote station upto 200 meters from the main equipment.

The RAM is required to be mounted vertically. This is ideally suitable for wall mounting. However, this also can be mounted inside a panel. The cut out dimensions for the panel mounting, are as shown in the clamps provided for wall mounting are required to be removed. (Refer drawing).

There are total 9 alarms provided on the RAM. Each of the alarm initiates an audible alarm warning. This is, however, subject to a short time delay to prevent the warning being activated by transient conditions. Pressing the reset push button cancels the audible warning but the alarm indications remain until the condition is rectified. A test push button is also provided to ensure that all the LED's are healthy.

Power Supply

The RAM contains a single-phase 230V a.c. mains driven power supply. Power is applied through a standard two-pin mains connector located at the backside of the RAM. This 2 pin male-female type connector is marked as (N) (L). The supply is rated to approximately 10 watts and hence can be tapped from any suitable source. This generates required DC power supply for functional requirement of the RAM. Once AC power is available to RAM, "POWER" indicating LED on RAM starts glowing. This indicates that RAM is ready for operation. This power supply is used to reproduce UPS mimic and display alarms.

Mimic and Alarm Connections

Refer figure 25 and 26.

For connection of RAM signals to interface PCB two different connectors are provided marked as RM-1 and RM-2. RM-1 is a six pin male-female connector and RM-2 is a 10 pin male-female connector. Both the connectors are with screwed terminals. The connection diagram of both the terminals with interface PCB is as shown in connection diagram. 24V d.c.supply is available on RM-3. This is required to be connected to M3: pin3 of Interface PCB. This 24 volts supply is required to be looped on interface PCB as shown with star marked connections. For connecting RAM and interface PCB's, use multicore 1.5sq.mm. stranded conductor, flexible copper cable. RAM actually requires 16 such cores. However, it is advisable to provide spare cores and hence we recommend use of 24-core cable.

For connection diagram of 1+1 UPS system refer figure 27.

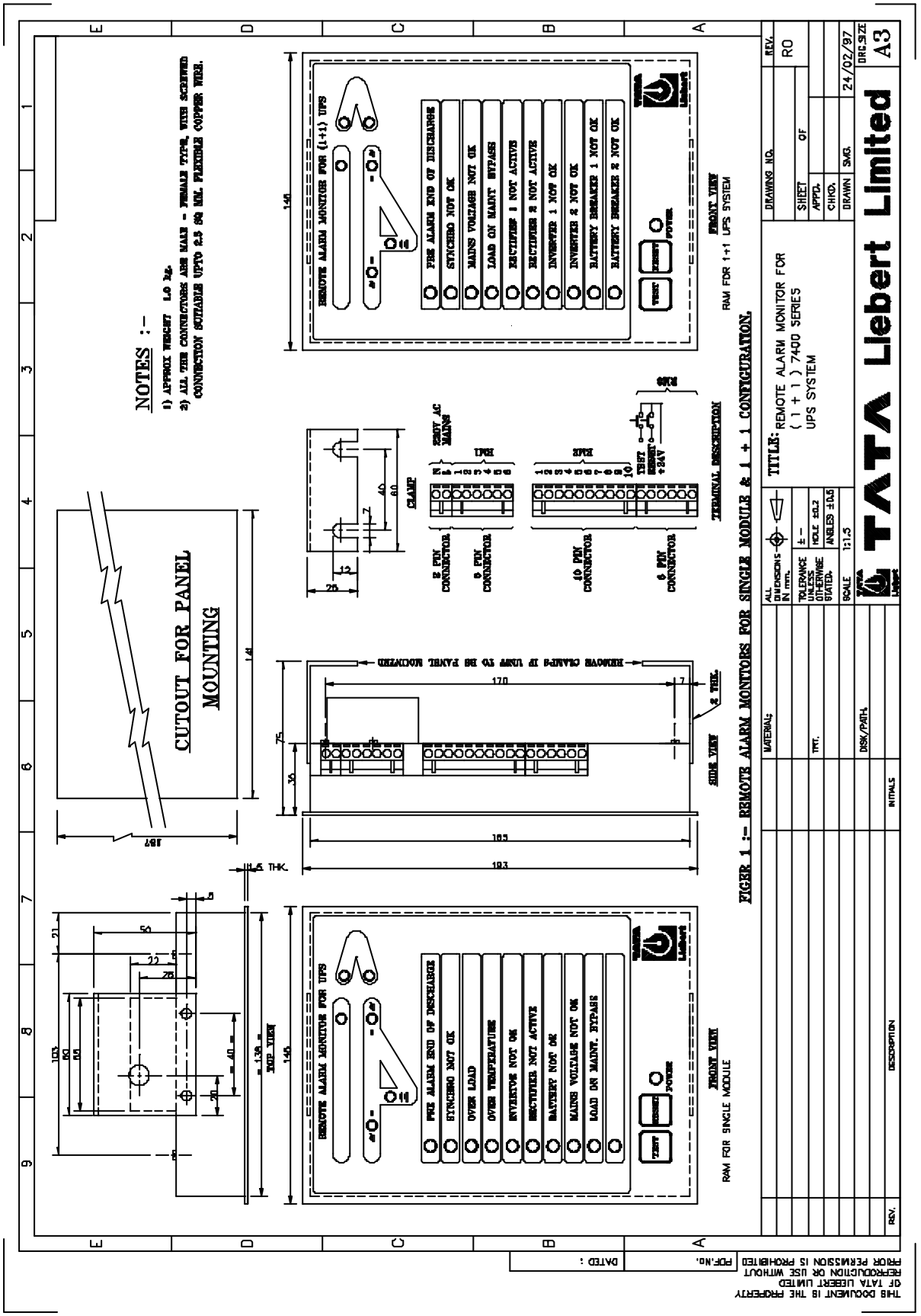
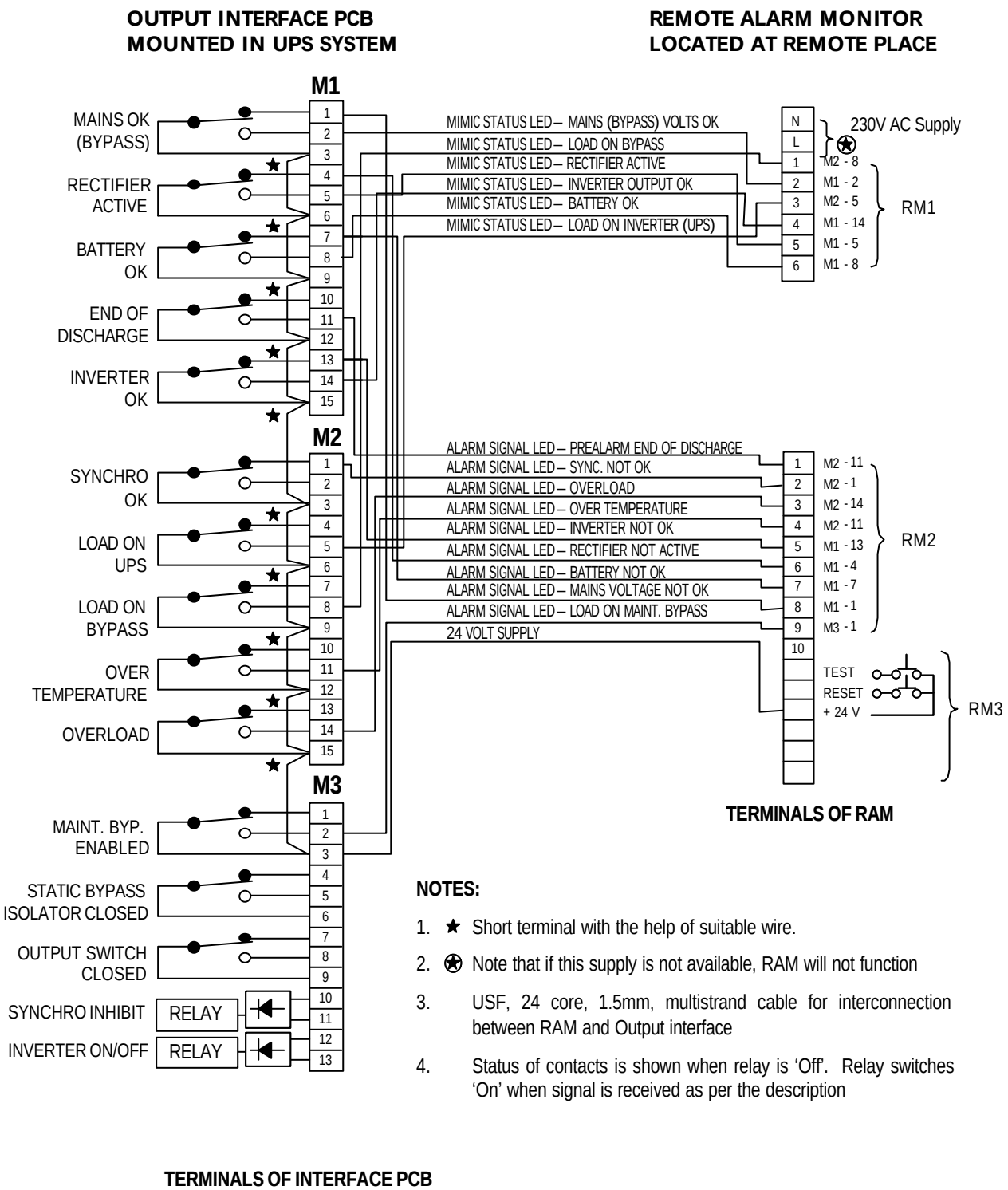


Figure 25: Remote alarm monitors for single module and 1+1 configuration



NOTES:

1. ★ Short terminal with the help of suitable wire.
2. ⊛ Note that if this supply is not available, RAM will not function
3. USF, 24 core, 1.5mm, multistrand cable for interconnection between RAM and Output interface
4. Status of contacts is shown when relay is 'Off'. Relay switches 'On' when signal is received as per the description

Figure 26: Interconnection diagram for single module RAM & Output Interface PCB

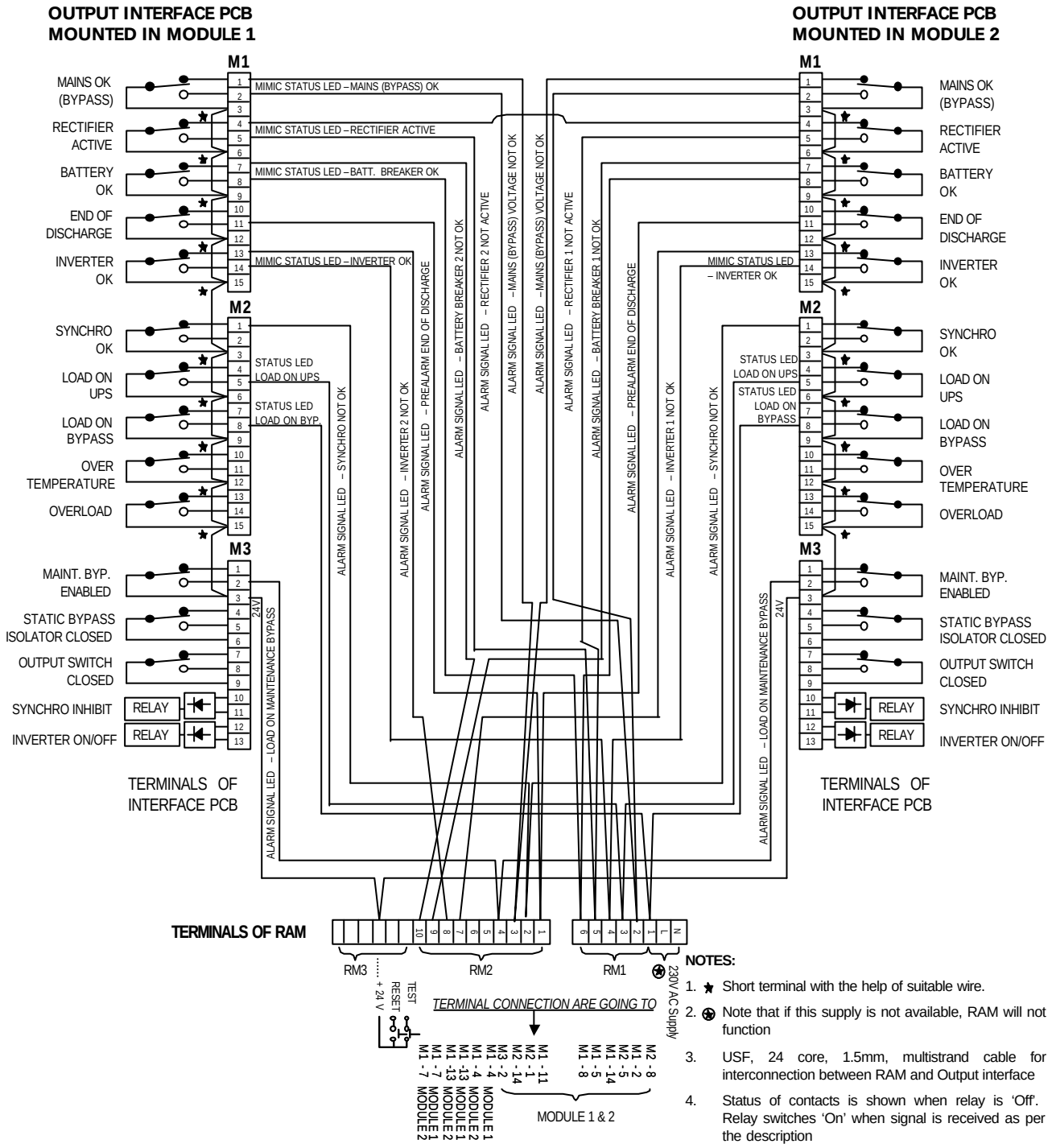


Figure 27: Interconnection diagram for single module RAM and UPS Interface PCB 1+1 System

Chapter 5
Maintenance

5.1 Introduction

This chapter contains the procedures necessary to effect general maintenance of the UPS module and battery. Certain procedures entail gaining internal access to the UPS, and should only be undertaken by a competent engineer who is familiar with the operation and layout of the equipment and understands the areas of potential hazard. If you have any doubts concerning safety or the method carrying out any procedure then contact an approved service agent for assistance or advice. If the locally approved agent is known to you, then you should contact the Customer Services & Support department at the address shown at the front of this manual.

The manufacturer offers customer training, at a nominal fee, if required. Such training can range from a one-day operator course to in-depth training on maintenance and troubleshooting lasting several days, and can be carried out at the manufacturer's plant or at the customer premises.

5.2 Safety Precautions

When working on the UPS remember that the equipment contains live voltages at *ALL TIMES* unless it is *externally* isolated from the mains supply, bypass supply and batteries. It is essential that the safety and precautionary notes contained throughout this manual are read and *FULLY UNDERSTOOD* before touching any UPS internal component part.

5.3 Scheduled Maintenance

The UPS utilises solid-state components which are not subject to wear, with the only moving parts being the cooling fans. Scheduled maintenance requirements, beyond ensuring that the environmental conditions remain suitably cool and clean, are therefore minimal. However, a well documented periodic program of inspection and preventive maintenance, as suggested below, will help to ensure optimum equipment performance and may serve to detect certain minor malfunctions prior to them developing into a major fault.

5.3.1 Daily Checks

Carry out a daily walk-by inspection of the UPS, checking the following points:

1. Carry out a spot check of the operator control panel; ensuring that all mimic LED indications are normal, all metered parameters are normal and no warning or alarm messages are present on the display panel.

2. Check for obvious signs of overheating.

3. Listen for any noticeable change in audible noise.

4. Ensure that the ventilation grills around the UPS are unobstructed.

5. If possible, log the results of the inspection, noting any discrepancies from the norm.

5.3.2 Weekly Checks

Carry out the following checks from the mimic panel and log the results:

1. Measure and record the battery float charge voltage.

2. Measure and record the battery charge current.

3. Measure and record the UPS output voltage on all three phases.

4. Measure and record the UPS output line currents. If these are significantly different from the values previously logged then, if possible, record the size, type and location of any additional load connected to the UPS supply since the previous inspection. This type of information could prove useful to the troubleshooting engineer should a problem occur.

   If any of the above indications differ greatly from the previously logged values for no apparent reason then you should contact the Customer Service & Support Department at the address given at the front of this manual for advice.

5.3.3 Annual Service

The equipment should be thoroughly cleaned and the following checks carried out annually. This entails working inside the equipment in regions containing hazardous voltages.

A manufacturer-trained engineer is fully aware of the hazards concerned and will carry out this procedure with the load connected to the maintenance bypass supply; however if the customer decides to carry out this service procedure himself it is imperative that the UPS be totally shut down and isolated from the input mains supply and bypass supplies and batteries using the procedure given below. We therefore strongly recommend that the annual service is carried out by trained personnel.

1. Carry out the weekly checks detailed above.

2. Shut down the UPS following the recommended operating procedure.

3. Isolate the UPS input mains supply externally (also the bypass supply if a split bypass is in use) and isolate the battery.

4. Ensure that the UPS is totally powered down by checking for voltage at the mains input terminals, battery connection terminals, and output terminals (and bypass mains input terminals in a split bypass configuration).

5. Gain full access to the UPS interior by opening its internal hinged safety panel.

6. Carry out a thorough examination of the UPS power components and sub-assemblies, paying particular attention to the following -

   Electrolytic capacitors - Check for signs of leakage, buckling etc.

   Magnetic components - Check for signs of overheating, security of fixture and signs of delamination.

   Cables and Connections - Check cables for chaffing, fraying or signs of overheating. Check that all printed circuit board connectors are secure.

   Printed circuit boards - Check the cleanliness and integrity of the circuit boards and replace if any signs of deterioration are found.

7. Thoroughly clean inside the equipment enclosure using a vacuum cleaner and low pressure air to remove any foreign debris.

8. Reconnect the UPS input mains power.

9. Start the UPS and transfer the load to the inverter following the appropriate operating procedure.

1. If possible, check the battery autonomy time by opening the input isolator (I1) with the UPS on-load. Close the input isolator immediately the DC busbar voltage falls to 325V (note that at 320V the battery circuit breaker will trip and the load will transfer to bypass). Ensure that the available battery autonomy time meets the installation specifications.

5.3.4 Extended Service

We recommend that ALL the input/output power cables and their connections are checked periodically. As this requires the UPS to be *completely* shut down such a check should be carried out on an 'opportunity' basis but at an interval not exceeding 2 years.

5.3.5 Battery Maintenance

The batteries used with the UPS are generally of a sealed, valve-regulated type, and the only maintenance requirement is to ensure that the cells are kept clean and dry. Maintenance procedures appropriate to both, valve-regulated and un-sealed batteries vary, and should be obtained from the battery manufacturer.

Chapter 6
Troubleshooting

6.1 Troubleshooting UPS systems

The UPS contains complex electronic control circuits that require a firm understanding in order to carry out comprehensive fault diagnosis and repair of the equipment. The following information aims to provide a trained user with sufficient knowledge to understand the nature of a fault through the correct interpretation of the accompanying alarms and indications, and to carry out any necessary first aid repair.

WARNING

Some of the instructions in the charts at the end of this chapter involve checking internal fuses. This should be undertaken (after the equipment has been shut down) only by a trained electrician who is familiar with the layout and operation of the equipment and fully conversant with the areas of potential hazard.

6.1.1 Operating Parameters and Limitations

There is no practical way of detecting an impending UPS malfunction. Most problems do not emerge as a gradual performance degradation; generally the UPS either works correctly or it will shut down - and transfer the load to the bypass supply if applicable. However, it is important to maintain a regular record of the UPS meter indications, as suggested in the maintenance instructions, in order that any change in the system or load characteristics are readily identified.

In general, the output voltage should be within 2% of nominal. If the UPS has not operated on battery power within the previous ten hours the battery charge current should be typically less than 6A.

If any indication differs significantly from the typical figures given above the cause should be investigated.

Information concerning prevailing load conditions can prove useful when discussing problems with the service agent - for example, details of any particular load being started or shed at the time that the fault occurred.

6.1.2 General Troubleshooting Procedure

Troubleshooting should be carried out methodically using the following guidelines-

Fault Identification

When first summoned to the scene of a UPS fault, your immediate action should be to observe and record the displayed messages, mimic indications, meter indications and the position of the UPS power isolator switches. This should be completed before you touch any switch.

Corrective Action

When all the indications have been noted, you should refer to the following fault interpretation charts and carry out the actions detailed against any led whose status is abnormal. If you are unsure as to how to undertake the actions detailed - or if several LED indications are abnormal and you are unable to distinguish between the likely cause and affects - then seek immediate assistance from an approved service agent.

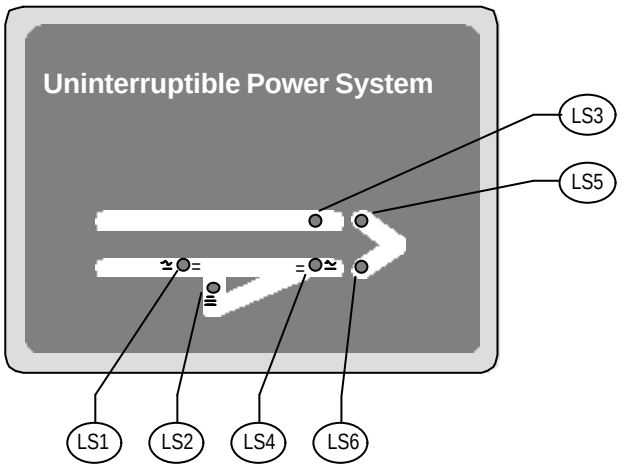
Fault Reporting

Irrespective of whether fault rectification is successful or not, report the fault occurrence to the nearest service agent - who will then forward the details to the manufacturer. This type of customer feedback is an important factor in maintaining high product reliability, and also provides important data concerning the equipment field performance.

CAUTION

The following diagnostic charts are designed for 'first aid' troubleshooting only. If a problem cannot be resolved by taking the actions given then fully trained assistance should be sought immediately.

Do not under any circumstances make internal circuit adjustments or interfere with the circuit boards in any other way.



LED NUMBER	NORMAL STATE	ACTIONS TO BE TAKEN IF ABNORMAL
LS1	ON	If this led is OFF it signifies a problem either with the incoming mains supply or the rectifier section. See accompanying alarm messages. Check the following: a) Input isolator is closed. b) Input supply voltage is within 20% of nominal c) Input fuses are O.K. d) Power supply fuses are OK *(Note: LS1 and LS2 on the AC Power Supply Board will be OFF if either of these fuses are ruptured).* e) Mains sensing fuses on the High Voltage Interface board F4, F5, F6 are OK. f) Check that slide switch I2 on the UPS Logic Board is closed. If the above checks prove satisfactory then seek qualified assistance.
LS2	ON	If this led is OFF it signifies that either the battery circuit breaker is open or that the dc busbar voltage is below 320V dc. (For 80kVA to 125kVA models, this voltage is 330V dc). The battery circuit breaker will open automatically if the dc voltage falls below this level. Check the following: a) Battery circuit breaker is closed. b) DC busbar voltage – if not above 320V then carry out checks as per LS1 (mains failure) above. If the dc busbar voltage is greater than 320V (and 330V dc for 80-125kVA models); If you are unable to close the battery circuit breaker, then seek qualified assistance. c) If the battery circuit breaker trips as soon as mains power is disconnected then check the dc power supply fuses.
LS3	ON	If this led is OFF it signifies either that the bypass supply is not within acceptable tolerances or that the bypass supply isolator is open. Check that the bypass supply isolator is closed, the supply is available and within specifications.

LED NUMBER	NORMAL STATE	ACTIONS TO BE TAKEN IF ABNORMAL
LS4	ON	If this led is OFF it signifies that the inverter is not producing its correct output voltage. Check the following: a) If [OVERTEMPERATURE] OR [OVERLOAD] alarm messages are active then (after allowing the UPS to cool / checking that the load current on the bypass line is not excessive) press the reset switch on the UPS Logic Board. b) Press the Inverter ON pushbutton c) If the dc busbar is below 320V (330V for 80-125 kVA) then do checks as per LS1 above d) Check that slide switch I3 is closed on the UPS Logic Board is closed. e) If the inverter works OK when mains is available but not when mains is unavailable then check the dc power supply fuses. If the above checks prove unsatisfactory then seek qualified assistance.
LS5**	OFF	If this led is ON then it signifies that the load has been transferred to the static bypass supply and the output circuit breaker is closed. This indication should be mutually exclusive with LS6 described below - check out LS6 actions.
LS6**	ON	If LS4 is also OFF then refer to LS4 checks. If LS6 is OFF but LS4 is ON then check the following: a) Ensure that the output isolator is closed then press the Reset button on the UPS Logic Board. b) Ensure that slide switch I3 on the Static Switch Logic Board is in the AUTO position. If the above checks prove unsatisfactory then seek qualified assistance.

** Note that in *one-plus-one* system configured with a redundant module, it is possible for one of the two modules to shut down (due to fault for example) without turning on its static switch. In fact when in a redundant module configuration a module's static switch is disabled whenever its partnering module is on line. Therefore in the event of a fault you are likely to see LS4, LS5 & LS6 all OFF.

6.2 Display Panel Message Interpretation

The following table lists the various messages displayed on the operator panel together with a description of their interpretation.

DISPLAY MESSAGE	INTERPRETATION
EMERGENCY STOP	This alarm indicates that the UPS was shut down by means of the local or remote (if fitted) emergency stop pushbutton which of course is normally due to operator action - investigate why the emergency stop pushbutton was pressed. If the emergency stop pushbutton was not pressed then check the continuity of the remote emergency stop line (if fitted), and if no remote emergency stop line is fitted then check that a link is connected between terminals 3 and 4 of the UPS auxiliary terminal block.
INVERTER OFF OR FAILED	This alarm is active whenever the inverter is not producing its correct output voltage; either because it has been switched OFF or due to an internal fault. The alarm will accompany other alarms such as [OVERLOAD], [LOAD ON BYPASS]
OVERTEMPERATURE	Overtemperature is sensed by a normally-closed thermostat (90º C operating) fitted to each inverter heatsink. If an overtemperature condition arises, the audible alarm will accompany this message - the inverter stops and load transfers to bypass after 3 minutes.
OVERLOAD	The inverter overload has an inverse load/time characteristic - i.e. it will accept 125% overload for 10 minutes and 150% for 60 seconds. If this characteristic is exceeded then the load transfers to the bypass supply, the inverter stops and the overload alarm annunciates. The [OVERLOAD] alarm will annunciate as soon as the load exceeds 100 % of the UPS rating, and the load will transfer to bypass some time later - depending on the degree of overload present.
BATTERY C/B OPEN	This is a status indication only. Note that UPS if operating with the battery circuit breaker open and the mains power fails then the UPS output will also fail together with load power. Also check battery fuses.
OUTPUT C.B. OPEN	This is a status alarm. This output isolator must be selected 'CLOSED' at all times except when operating on the maintenance bypass supply.
RECTIFIER OFF OR FAILED	This alarm is active whenever the battery charger (rectifier) is not producing its correct output voltage; due to either an input supply failure, an internal fault, or an open input circuit breaker.

DISPLAY MESSAGE	INTERPRETATION
UPS ON MAINTENANCE BYPASS	This is a status warning that the load is being powered through the maintenance bypass line and is unprotected from mains supply abbreviations. Due to the fact that the UPS power supplies are fed by the input circuit breaker, this message will disappear if the input isolator is opened (and bypass isolator opened on a split bypass system) while the load is on maintenance bypass supply.
INVERTER UNSYNCHRONISED	This warns that the inverter is not synchronised with the bypass supply, which is normally due to a problem with the bypass supply being outside an acceptable frequency window. Do not switch OFF the inverter when this alarm is active or the load will experience a 20-millisecond power break.
BATTERY ON LOAD	This is a status warning that the battery is discharging. It normally accompanies a [MAINS FAILURE] / [BYPASS FAILURE] or [RECTIFIER OFF OR FAILED] message.
MAINS FAILURE	MAINS FAILURE or mains supply out of specified acceptable range. Do not switch OFF the inverter while this indication is active or the load will lose its power.
LOAD ON BYPASS	This is a status warning that the load is being powered through the static bypass line and is unprotected from mains supply aberrations.

ANNEXURE

Inter Connection cable details

Any system essentially needs UPS module. However many customers need auxiliary cubicles such as Input Isolation Transformers, Battery Current Sharing Kit, 1+1 Paralleling kit, Bypass SCVS / SVR or Bypass Line Transformers. In case any of the auxiliary cubicle or combination of them is required & ordered by the customer, we would like to recommend following sequence in which the cubicles shall be located.

SCVS or SVR	TXR Cubicle 1	UPS 1	UPS 2	TXR Cubicle 2 or Battery Sharing Kit

It should be noted that this is the recommended panel line up & based on this line up we will provide all interconnection cables. The interconnecting cables are supplied only if auxiliaries are in ENP's scope. ENP is not responsible for supply of these interconnection cables in case the recommended Line up is altered. It is presumed that

a) All the panels are in single line up.
b) All the panels are placed in such a way that side covers are touching to each other.
c) Location of UPS panels remain unchanged.
d) In case any of the panel is not ordered its left hand side panel shall be shifted to ensure no gap between UPS & other panels i.e. in case Transformer Cubicle is not required the SCVS or SVR will be placed at the location of Transformer Cubicle.

We are enclosing the typical interconnection diagram which will remain unchanged for all permutations & combinations of various options.